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A compendium of fisheries indicators for target tuna stocks in the WCPFC Convention Area

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WCPFC-SC16-2020/SA-WP-01

(Rev. 01)

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Revision 1 (11 August 2020)

Changes: Albacore total catch data updated (summarized in Description for Figure 9). Correction to text summarizing 'Catch by other gear', also in the Description for Figure 9

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1 Executive Summary

The principal purpose of this paper is to provide empirical information on recent patterns in fisheries for the SC's consideration. For SC16, we present a compendium of fishery indicators for all 'key' target tuna species (skipjack, bigeye, yellowfin and South Pacific albacore tuna), with albacore and skipjack not having full stock assessments in 2020. Trends for South Pacific albacore tuna are also described in the regularly requested stand-alone paper Hare et al. (2020).

The indicators that are documented include: total catch by gear, nominal CPUE trends, spatial distribution of catch and associated trends, size composition of the catch and trends in average size. These include data loaded into the WCPFC databases as of 11 August 2019. Commentary provided in this paper typically relates to comparisons of the values of various indicators to previous years, in particular comparisons of 2019 values to 2018 and to the average over 2014-2018.

It is difficult to confidently interpret the stock status-related implications of trends in any indicators in isolation from other data sets and a population dynamics model. Therefore, short-term stochastic projections for WCPO albacore and skipjack stocks are also presented to assess potential stock status at the end of 2021 in light of recent catch and effort trends.

2 Introduction

Following development of stock indicators for key species not formally assessed (Scientific Committee's Work Programme for 2008-2010, Project 24), stock indicators were first reported to SC4 in 2008 by the paper of Hampton and Williams (2008). Indicators for all key tuna species have been reported regularly since 2012 (Harley and Williams, 2012; Harley and Williams, 2013; Pilling et al., 2016; Pilling et al., 2017; Brouwer et al., 2018; Brouwer et al., 2019). The more recent papers addressed the request from SC9 for descriptive text to assist in interpreting the paper contents.

Stock indicators for skipjack, bigeye, yellowfin and South Pacific albacore tuna are presented here. Bigeye and yellowfin tuna had full assessments conducted this year (Ducharme-Barth et al., 2020 and Vincent et al., 2020, respectively). Skipjack was last assessed in 2019 (Vincent et al., 2019) and albacore in 2018 (Tremblay-Boyer et al., 2018). Commentary provided in this paper compares the values of various indicators to previous years, in particular comparisons of 2019 values to 2018 and to the average over 2014-2018.

Short-term stochastic projections for albacore and skipjack are also included for further information; projections for bigeye and yellowfin are not provided, as assessments were conducted in 2020 and the final model grids have not yet been approved by SC (though some projections will likely be provided in the assessment presentations). For albacore and skipjack, the stocks were projected forward from 2016 and 2018, respectively, using the most recent assessments (Tremblay-Boyer et al., 2018; Vincent et al., 2019). Future recruitments were modeled as deviations around the stock recruitment relationship from the period over which the stock-recruitment relationship was estimated within the assessment model. For each stock, projections were performed over the grid of assessment runs defined by SC14 (South Pacific albacore) and SC15 (skipjack) as appropriate. For South Pacific albacore, the stock was projected through 2017, 2018 and 2019 using actual catch levels, and then through to 2021 assuming 2019 levels continued. For skipjack, the latest assessment ends in 2018. Therefore the stock was projected through 2019 using actual catch and effort levels, and then through to 2021 assuming 2019 fishing levels continued. We note that the near-future stock status will be influenced by recent recruitment levels defined within the stock assessment model, rather than the random recruitments sampled from the historical period. Those recruitments will take a number of years to reach the adult biomass, dependent on species.

3 Indicators and data sources

Indicators are based on annual catch estimates for the WCPFC Convention Area, and aggregate catch and effort data for the gear specific analyses. In some instances, individual fleets have been used for particular indicators. Given the large number of indicators, the descriptive text is tabulated below for each stock.

Please note that the figures here may include or exclude specific fleets that are included in summaries made for other purposes (e.g. CMM tables) and therefore these numbers may not be identical to those produced elsewhere. Furthermore, these numbers will change as more data become available.

Acknowledgments

The authors would like to thank Elizabeth Heagney, Paul Hamer, Jed MacDonald and Sampson Cornelius McKechnie for useful comments on earlier drafts of this paper.

4 References

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Skipjack tuna

Figure	Indicator	Description
Figure 1	Total catch by gear	Total catch in 2019 was 2,034,230t, a 10% increase from 2018 and a 13% increase from 2014-2018. Purse seine catch in 2019 (1,641,920t) was a 13% increase from 2018 and a 16% increase from the 2014-2018 average. Pole and line catch (126,273t) was a 31% decrease from 2018 and a 17% decrease from the average 2014-2018 catch. Catch by other gears (see Williams and Ruaia (2020) for descriptions) totaled 260,578t and was a 26% increase from 2018 and 14% increase from the average catch in 2014-2018.
Figure 2 - top	Tropical pole and line CPUE	Pole and line CPUE for the Japanese fleet in 2019 (7.86t per day) was a 1% decrease from 2018 and an 18% increase from the 2014-2018 average. Pole and line CPUE for the Solomon Islands fleet in 2019 (1.18t per day) was a 34% decrease from 2018 and a 38% decrease from the 2014-2018 average. This high variability is likely due to the small size of the fleet rather than an indication of stock abundance.
Figure 2 - bottom	Tropical purse seine CPUE	Free-school CPUE in 2019 (15.72t per day) was a 19% increase from 2018 and no change from the 2014-2018 average. Log-associated CPUE in 2019 (17.87t per day) was a 4% decrease from 2018 and an 8% decrease from the 2014-2018 average. Drifting FAD CPUE in 2019 (23.55t per day) was a 5% increase from 2018 and a 12% decrease from the 2014-2018 average. Anchored FAD CPUE in 2019 (3.82t per day) was a 56% decrease from 2018 and a 51% decrease from the 2014-2018 average.
Figure 3	Maps of catch by gear	Compared to the longer time frame, the reduction in pole and line catch in recent years is notable, particularly in the equatorial zone. The easterly distribution of purse seine catches in 2015-2019) has been influenced by a preponderance of El Niño-like conditions, including a relatively weak El Niño event during the first half of 2019.
Figure 4	Purse seine effort and CPUE maps	Purse seine CPUE has generally been higher in the central and eastern regions of the tropical WCPO, with some notably high catch rates achieved at the margins of this area, particularly towards the southeast region. The easterly distribution of purse seine catches in 2015-2019 derives from the influence of recent ENSO conditions, as weak El Niño conditions have persisted over the past few years.
Figure 5	Spatial concentration of catch	90% of the purse seine catch in 2019 was taken in 582 1^ox 1^o squares. This was a 9% decrease on 2018 and a 10% decrease on 2014-2018 average. Over the longer term (20 years), the minimum number of 1^ox 1^o squares in which 90% of the purse sene catch has been taken has fluctuated between 500 and 700, showing a slight increase over that time frame. 90% of the pole and line catch was taken in 322 1^ox 1^o degree squares. This was a 17% increase on 2018 and a 3% increase on 2014-2018 average. Similar to purse seine, the fishery has been relatively steady over the past 20 years in terms of how many 1^ox 1^o cells (between 250 and 350) from which 90% of the catch has been taken.
Figure 6	Catch at length by gear type in both numbers and weight	The catch at length in numbers of fish is broadly bimodal. One peak comprises small fish, generally smaller than 40 cm, taken in the Indonesia/Philippines fisheries; the other peak is comprised of larger fish, generally between 45 and 70 cm, mostly caught in the purse seine fisheries. While numbers of skipjack caught is roughly equal between the two fisheries, catch by weight is dominated by the purse seine fisheries. The peak of the length mode in both purse seine fisheries was several cm larger than in 2018

Figure	Indicator	Description
Figure 7	Mean weight by gear type	The mean weight of individual fish taken across all gears in 2019 (1.92kg) was an 11% increase from 2018 and a 2% increase from the average in 2014-2018. The mean weight of pole and line caught fish (2.5kg) was a 25% increase from 2018 and a 5% increase from the average in 2014-2018. The mean weight of Indonesia / Philippines domestic caught fish (0.52kg) was an 11% increase from 2018 and a 4% decrease from the average in 2014-2018. The mean weight of free-school caught purse seine fish (4.05kg) was an 8% increase from 2018 and no change from from the average in 2014-2018. The mean weight of FAD caught fish (2.43kg) was a 27% increase from 2018 and a 6% increase from the average in 2014-2018.
Figure 8	Stochastic stock projections	Under recent fishery conditions, the skipjack stock is projected to decline slightly. The projections indicate that, median $F_{2021}/F_{MSY} = 0.51$; median $SB_{2021}/SB_{F=0} = 0.39$; median $SB_{2021}/SB_{MSY} = 2.36$. The risk that $SB_{2021}/SB_{F=0} < LRP = 0\%$, $SB_{2021} < SB_{MSY} = 0\%$ and $F_{2021} > F_{MSY} = 1\%$.

South Pacific albacore tuna

Figure	Indicator	Description
Figure 9	Total catch by gear	Total provisional South Pacific catch in 2019 was 86,706t, a 5% increase from 2018 and a 6% increase from the average 2014-2018. Longline catch in 2019 (82,070t) was a 4% increase from 2018 and a 4% increase from the 2014-2018 average. Note the discussions in Williams (2019) and Williams and Reid (2019) on the catch reporting of albacore in the South Pacific ocean for more details. Catch by other gear - mostly troll - (4,593t) was a 49% increase from 2018 and a 68% increase from the average catch in 2014-2018. For the southern WCPFC-CA, total albacore catch was 71,956, a 6% increase from 2018 and a 9% increase from the average 2014-2018. Longline catch in 2019 (67,320t) was a 4% increase from 2018 and a 6% increase from the 2014-2018 average. Catch by other gear (mostly troll catch) (4,593t) was a 48% increase from 2018 and 64% increase from the average catch in 2014-2018. Note that numbers will differ slightly to those tabulated in the albacore trends paper (Hare et al., 2020).
Figure 10	Southern longline CPUE (south of 10^{o}S)	Japanese longline CPUE in 2019 (1 fish per 100 hooks) was a 4% increase from 2018 and a 25% decrease from the 2014-2018 average. Korea longline CPUE (0.76 fish per 100 hooks) was a 9% decrease from 2018 and a 31% increase from the 2014-2018 average. Chinese longline CPUE (1.1 fish per 100 hooks) was a 36% decrease from 2018 and a 33% decrease from the 2014-2018 average. Finally, Chinese Taipei longline CPUE in 2019 (1.53 fish per 100 hooks) was a 21% decrease from 2018 and a 19% decrease from the 2014-2018 average.
Figure 11	Maps of catch by gear	In recent years, catches have concentrated in the 10^o-20^{o}S latitudinal band. While 2019 estimates remain provisional, slightly higher catch is seen in the high seas and around 170^{o}E. Catch has increased south of 20^{o}S in the high seas east of 180^o since 2018. Overall in 2019 the catch distribution is somewhat shifted towards the west.
Figure 12	Longline effort and CPUE maps	Over the whole period, catch rates have been highest south of 10^{o}S, and the overall pattern is for increasing CPUE as you move from north to south. In the more recent period, catch rates have been relatively high within high seas areas and in the 15-20^{o}S band around 170^o E.
Figure 13	Spatial concentration of catch	90% of the longline catch in 2019 was taken in 54 5^{o}x 5^o degree squares of the southern WCPO. This was no change from 2018 and a 5% increase from the 2014-2018 average.
Figure 14	Catch at length by gear type in both numbers and weight	The catch in numbers of fish and weight shows that the largest fish are caught in the longline fisheries and the troll catch is made up of small fish usually less than 80cm in length. There is little apparent trend in the peak of the longline length mode, but a pronounced peak in 'Other' gear catch is noted at 60 cm.
Figure 15	Mean weight by gear type	While the mean weight of individual fish taken across all gears is relatively stable over the long-term, 2019 (14.67kg) was a 2% increase from 2018 and a 2% increase from the 2014-2018 average. The mean weight of longline caught fish (16.34kg) was a 3% increase from 2018 and a 6% increase from the 2014-2018 average. The mean weight of fish caught in other gears (4.27kg), almost all troll, was a 8% increase from 2018 and a 8% decrease from the 2014-2018 average.

Figure	Indicator	Description
Figure 16	Stochastic stock projections	Under recent fishery conditions, the albacore stock is initially projected to to be maintained at recent levels as recent estimated relatively high recruitments support adult stock biomass, and then to decline as future recruitment is sampled from the long-term historical estimates. The projections indicate that, median $F_{2021}/F_{MSY} = 0.32$; median $SB_{2021}/SB_{F=0} = 0.37$; median $SB_{2021}/SB_{MSY} = 2.91$. The risk that $SB_{2021}/SB_{F=0} <$ LRP = 13%, $SB_{2021} < SB_{MSY}$ = 0% and $F_{2021} > F_{MSY}$ = 0%. The probability that the stock is at or above the TRP ($SB_{2021}/SB_{F=0} >= TRP$) = 18%.

Bigeye tuna

Figure	Indicator	Description
Figure 17	Total catch by gear	Total catch in 2019 was 135,680t, a 9% decrease from 2018 and a 8% decrease from the average 2014-2018. Longline catch in 2019 (68,371t) was a 0% decrease from 2018 and a 2% increase from the 2014-2018 average. Purse seine catch in 2019 (50,819t) was a 22% decrease from 2018 and a 17% decrease from the 2014-2018 average. Pole and line catch (1,400t) was a 66% decrease from 2018 and a 66% decrease from the average 2014-2018 catch. Catch by other gear (see Williams and Ruaia (2020) for descriptions) totaled 15,090t and was a 33% increase from 2018 and 1% increase from the average catch in 2014-2018.
Figure 18 - top	Tropical pole and line CPUE	Japanese pole and line CPUE in 2019 (0.002t per day) was a 85% decrease from 2018 and 87% decrease from the average CPUE in 2014-2018.
Figure 18 - middle	Tropical purse seine CPUE	Free-school CPUE in 2019 (0.16t per day) was a 32% decrease from 2018 and a 33% decrease from the 2014-2018 average. Log-associated CPUE in 2019 (0.92t per day) was a 20% decrease from 2018 and a 39% decrease from the 2014-2018 average. Drifting FAD CPUE in 2019 (1.24t per day) was a 26% decrease from 2018 and a 42% decrease from the 2014-2018 average. Anchored FAD CPUE in 2019 (0.04t per day) was a 82% decrease from 2018 and a 87% decrease from the 2014-2018 average.
Figure 18 - bottom	Tropical longline CPUE (20^{o}N to 10^{o}S)	Japanese longline CPUE in 2019 (0.42 fish per 100 hooks) was a 7% decrease from 2018 and 19% decrease from the average CPUE in 2014-2018. Korean longline CPUE (0.61 fish per 100 hooks) was a 9% increase from 2018 and 5% increase from the average CPUE in 2014-2018. US (Hawaiian) longline CPUE (0.3 fish per 100 hooks) was an 8% decrease from 2018 and a 17% decrease from the average CPUE in 2014-2018.
Figure 19	Maps of catch by gear	Compared to the longer time frame, a higher proportion of the catch in recent years has been taken by purse seine, and longline catches have concentrated more into the 10^{o}N-10^{o}S equatorial band.
Figure 20	Longline effort and CPUE maps	Longline CPUE in the recent period has generally been lower than that seen across the longer time frame. Higher catch rates are now generally limited to the equatorial eastern region of the WCPFC-CA.
Figure 21	Purse seine effort and CPUE maps	While areas of high bigeye catch rates have become more fragmented in recent years, higher catch rates in the tropical eastern region still expand further west in the tropical northern hemisphere (to 10^{o}N) and to the southeast of the tropical region.
Figure 22	Spatial concentration of catch	90% of the longline catch in 2019 was taken in 105 5^{o}x 5^o degree squares of the southern WCPO. This was a a 6% increase from 2018 and a 4% increase from the 2014-2018 average. 90% of the purse seine catch in 2019 was taken in 530 5^{o}x 5^o degree squares of the southern WCPO. This was a 18% decrease from 2018 and a 14% decrease from the 2014-2018 average.
Figure 23	Catch at length by gear type in both numbers and weight	The catch in numbers of fish was predominantly made up of small fish (<50cm) in the most recent years from the Indonesia/Philippines fisheries. Larger fish (>100cm), as well as the majority of the total catch, are generally caught in the longline fisheries. Intermediate sized fish are taken in the purse seine fisheries.The number of small bigeye caught in the Indonesia/Philippines fiserheis, in the 10-30 cm range, increased considerably in 2019 from the numbers seen in 2017 and 2018.

Figure	Indicator	Description
Figure 24	Mean weight by gear type	The mean weight of individual fish taken across all gears in 2019 (3.64kg) was a 39% decrease from 2018 and a 29% decrease from the average in 2014-2018. The mean weight of longline caught fish (42.47kg) was 1% increase from 2018 and a 1% decrease from the average in 2014-2018. The mean weight of Indonesia / Philippines domestic caught fish (0.58kg) was 40% decrease from 2018 and a 31% decrease from the average in 2014-2018. The mean weight of free-school caught purse seine fish (10.34kg) was 6% decrease from 2018 and a 24% decrease from the average in 2014-2018. The mean weight of FAD caught fish (5.49kg) was 7% increase from 2018 and a 9% decrease from the average in 2014-2018.
NA	Stochastic stock projections	NA - as a new assessment has been undertaken in 2020, and final grid still to be selected by SC, no projection is presented for bigeye here, however Ducharme-Barth et al. (2020) will aim to present some projections based on the new assessment.

Yellowfin tuna

Figure	Indicator	Description
Figure 25	Total catch by gear	Total catch in 2019 was 669,362t, a 5% decrease from 2018 and a 1% increase from the average 2014-2018. Purse seine catch in 2019 (364,571t) was a 4% decrease from 2018 and an 8% decrease from the 2014-2018 average. Longline catch in 2019 (104,440t) was a 7% increase from 2018 and a 9% increase from the 2014-2018 average. Pole and line catch (37,563t) was a 43% increase from 2018 and a 40% increase from the average 2014-2018 catch. Catch by other gear (see Williams and Ruaia (2020) for descriptions) totaled 162,788t and was an 18% decrease from 2018 and a 16% increase from the average catch in 2014-2018. This is mainly due to the large fluctuations in estimates for the other gears in Indonesia in recent years.
Figure 26 - top	Tropical pole and line CPUE	Japanese pole and line CPUE in 2019 (0.023t per day) was a 43% decrease from 2018 and a 47% decrease from the average catch in 2014-2018. At the time of writing this report the Solomon Islands CPUE is too variable to be informative, probably due to the small size of that fishery.
Figure 26 - middle	Tropical purse seine CPUE	Free-school CPUE in 2019 (3.65t per day) was a 10% decrease from 2018 and a 25% decrease from the 2014-2018 average. Log-associated CPUE in 2019 (4.55t per day) was an 11% decrease from 2018 and an 18% decrease from the 2014-2018 average. Drifting FAD CPUE in 2019 (3.49t per day) was a 4% increase from 2018 and a 21% decrease from the 2014-2018 average. Anchored FAD CPUE in 2019 (2.72t per day) was a 62% decrease from 2018 and a 59% decrease from the 2014-2018 average.
Figure 26 - bottom	Tropical longline CPUE (20^oN to 10^oS)	Japanese longline CPUE in 2019 (0.94 fish per 100 hooks) was a 15% increase from 2018 and a 27% increase from the average catch in 2014-2018. Korean longline CPUE (0.94 fish per 100 hooks) was a 144% increase from 2018 and 44% increase from the average catch in 2014-2018.
Figure 27	Maps of catch by gear	Compared to the longer time frame, a slightly higher proportion of the catch in recent years has been taken by purse seine within the 10^oN-10^oS equatorial band, with catches higher in the mid-tropical WCPO band, mirroring skipjack. Catch in the Indonesian/Philippines region remains notably high.
Figure 28	Longline effort and CPUE maps	Longline CPUE in the recent period has generally been lower than that seen across the longer time frame. Relatively high catch rates are now found only in the tropical western region of the WCPFC-CA. There is a strong contraction in the high CPUE area compared to the long-term.
Figure 29	Purse seine effort and CPUE maps	Areas of high CPUE have fragmented over time, across the tropical WCPFC-CA, and were concentrated in the west of the tropical region in 2019, with some localised high CPUE achieved in other areas.
Figure 30	Spatial concentration of catch	90% of the longline catch in 2019 was taken in 102 5^ox 5^o degree squares of the southern WCPO. This was a a 16% increase from 2018 and a 18% increase from the 2014-2018 average. 90% of the purse seine catch in 2019 was taken in 494 5^ox 5^o degree squares of the southern WCPO. This was a 12% decrease from 2018 and a 6% decrease from the 2014-2018 average.
Figure 31	Catch at length by gear type in both numbers and weight	The catch in numbers of fish was predominantly made up of small fish (<50cm) from the Indonesia/Philippines fisheries. Large fish are mostly caught in the longline and unassociated purse seine fisheries and larger yellowfin dominate the catch by weight, in contrast to catch in number. The total number of yellowfin taken in the Indonesia/Philippines fisheries was down from the high numbers seen in the 2018 catch.

Figure	Indicator	Description
Figure 32	Mean weight by gear type	The mean weight of individual fish taken across all gears in 2019 (2.72kg) was a 22% increase from 2018 and a 13% decrease from the average in 2014-2018. The mean weight of longline caught fish (29.13kg) was 4% decrease from 2018 and a 5% decrease from the average in 2014-2018. The mean weight of Indonesia / Philippines domestic caught fish (0.93kg) was a 11% increase from 2018 and a 3% decrease from the average in 2014-2018. The mean weight of free-school caught purse seine fish (17.81kg) was a 25% increase from 2018 and 2% increase from the average in 2014-2018. The mean weight of FAD caught fish (4.54kg) was a 24% increase from 2018 and a 4% decrease from the average in 2014-2018.
NA	Stochastic stock projections	NA - as a new assessment has been undertaken in 2020, and final grid still to be selected by SC, no projection is presented for skipjack here, however Vincent et al. (2020) will aim to present some projections based on the new assessment.

5 Figures

Skipjack

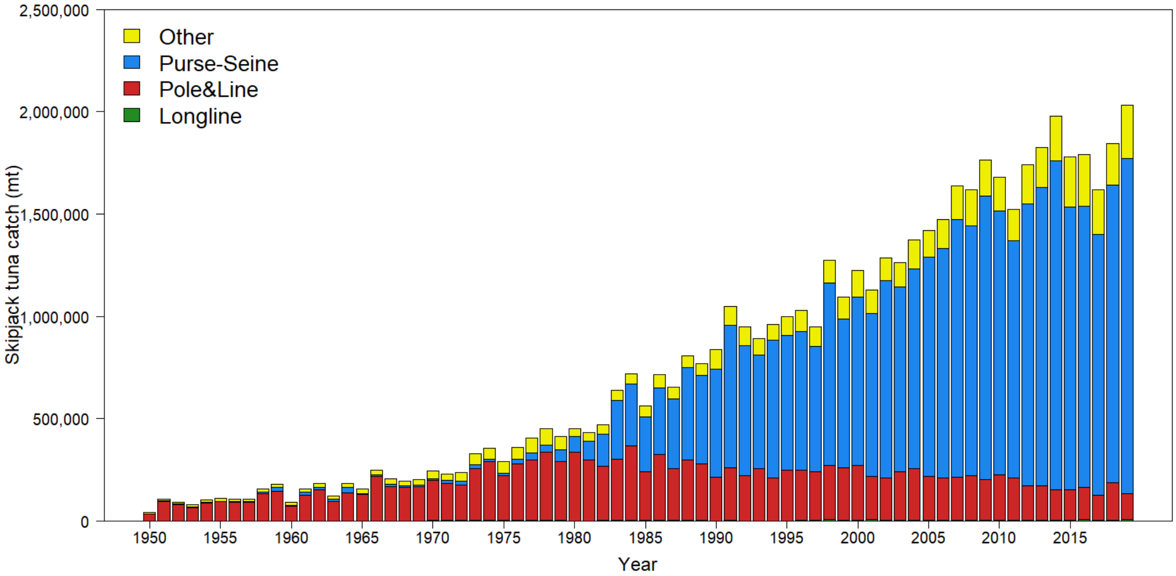


Figure 1: Skipjack tuna catch by gear type and year for the WCPFC-Convention Area.

Figure 2: Skipjack tuna catch per unit effort in the tropical WCPO by year for major pole and line fishing fleets (top), and purse seine (all fleets combined) for the major set types (bottom). Note different time series lengths.

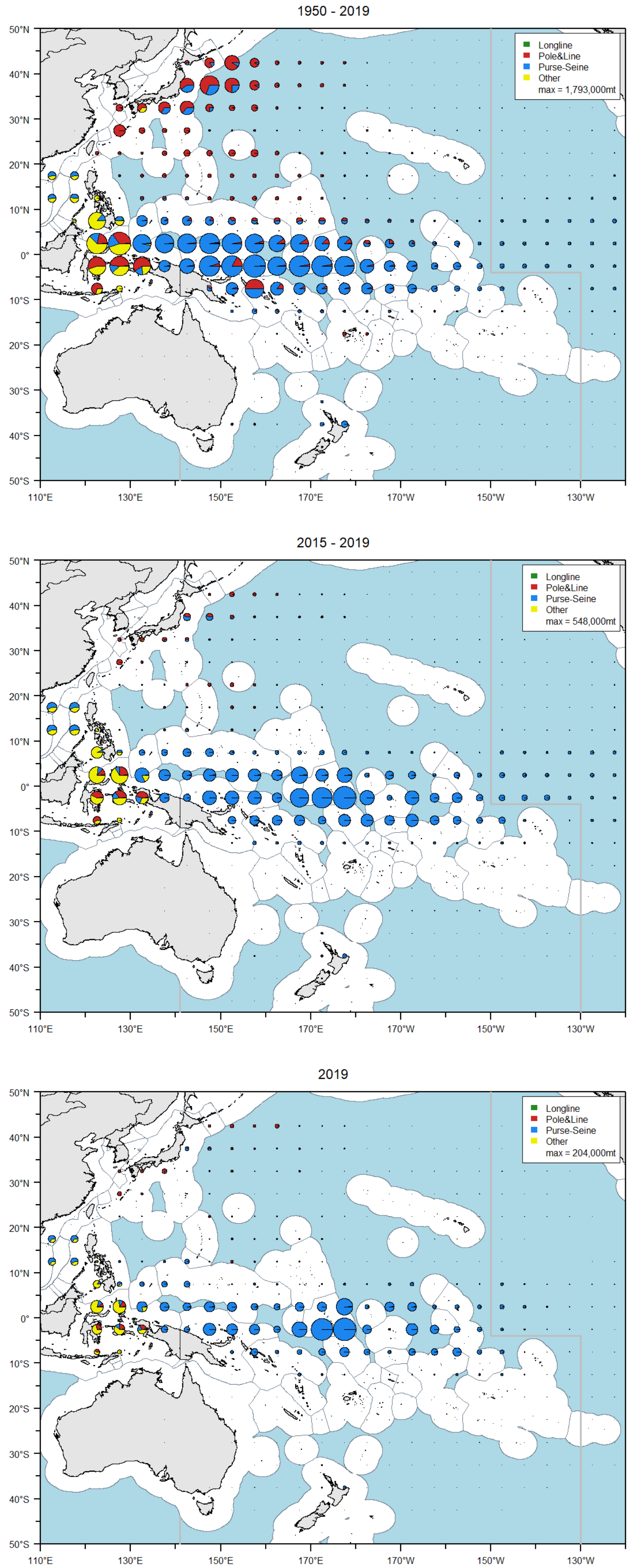


Figure 3: Skipjack tuna catch distribution by gear type and 5^ox 5^o region for the entire Pacific Ocean for the period 1950-2019 (top), 2015-2019 (middle) and 2019 (bottom). Note that the scale differs between panels and the figure legends provide the catch associated with each maximum circle size.

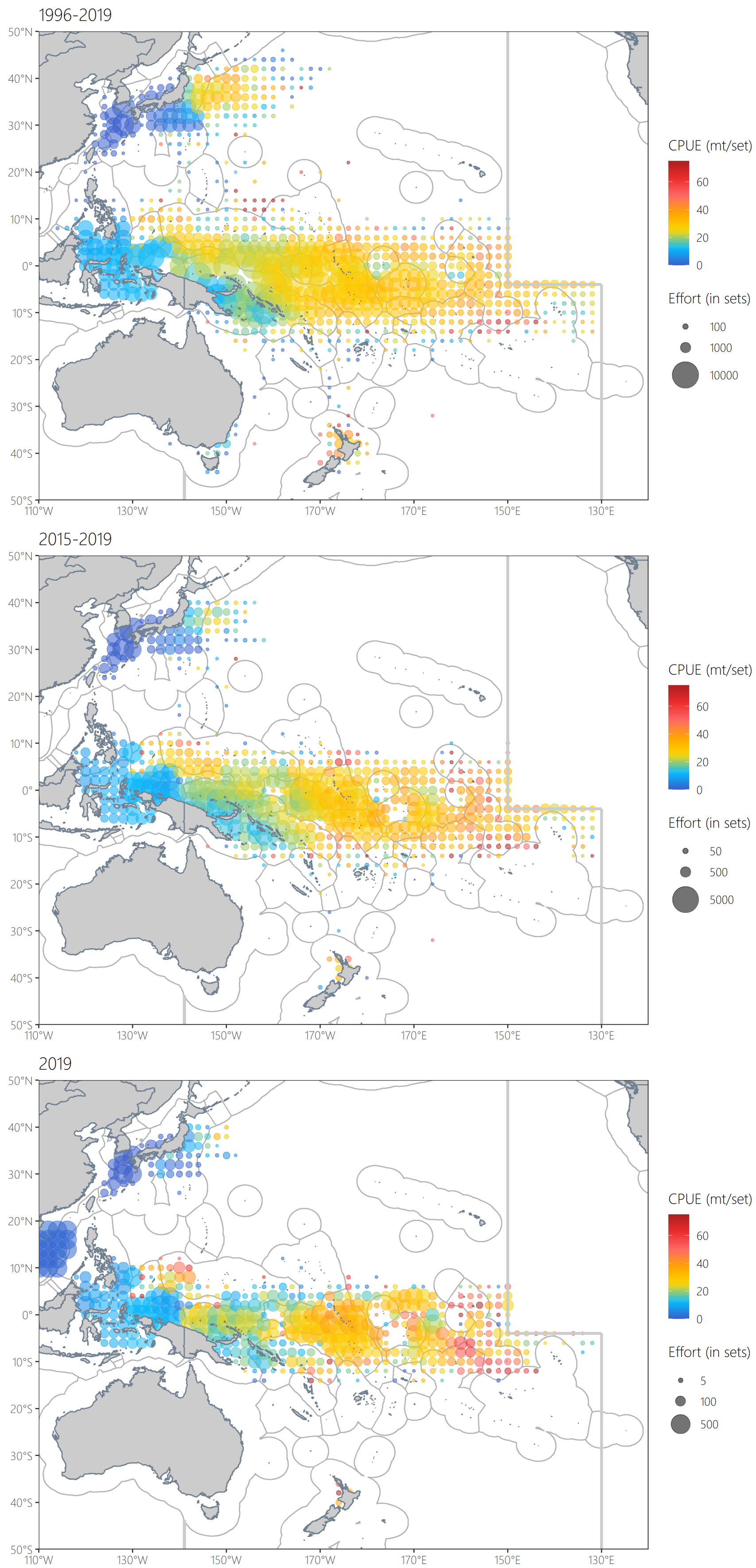


Figure 4: Distribution of 2°x 2° purse seine effort (represented by circle size) and skipjack tuna CPUE (represented by colour) for the period 1950-2019 (top), 2015-2019 (middle) and 2019 (bottom). Note the differences in scales between plots.

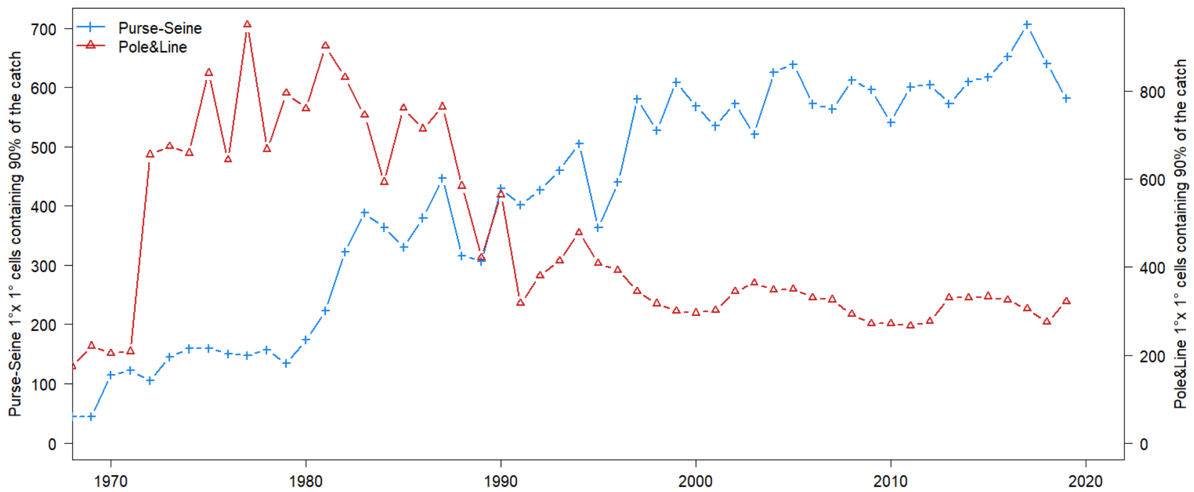


Figure 5: Spatial concentration of skipjack tuna catch for purse seine and pole and line fisheries by year for the WCPO.

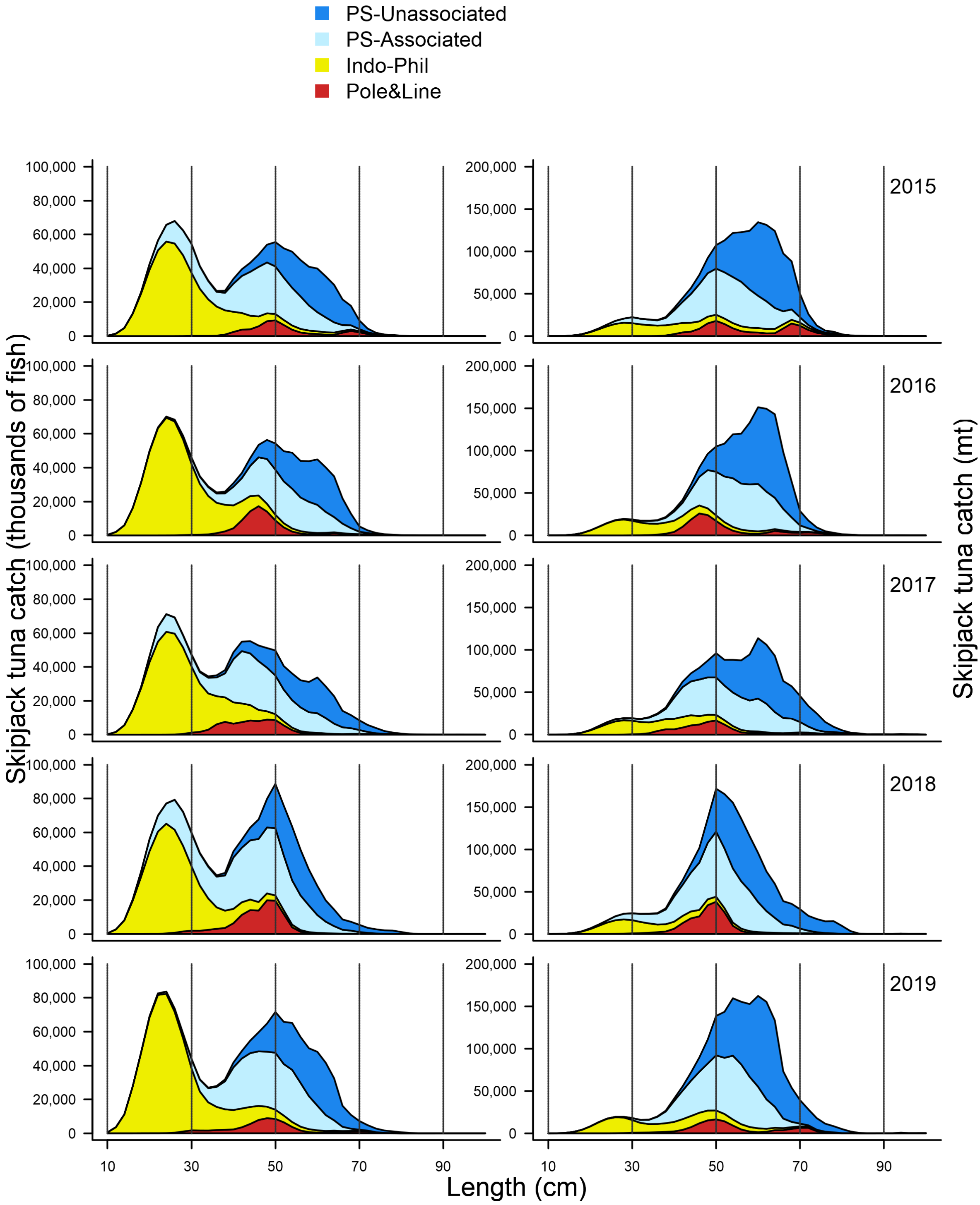


Figure 6: Catch-at-size of skipjack tuna by gear type and year for the WCPO. Catch is provided in thousands of fish (left) and metric tonnes (right). The grey vertical lines are guides to aid interpretation.

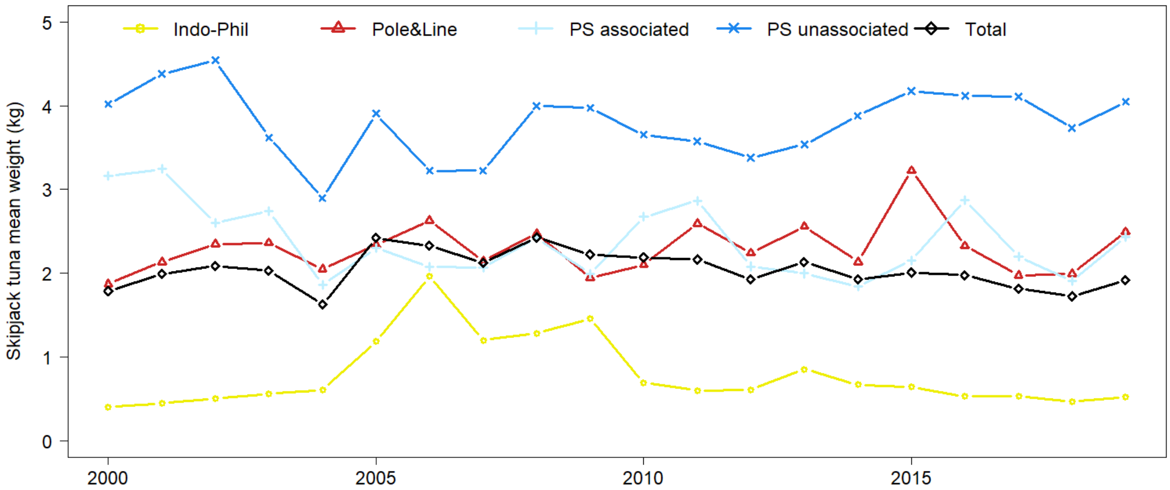


Figure 7: Mean weight of individual skipjack tuna taken by gear and year for the WCPO. The 'total' line represents the overall mean catch-at-size by number. Note: previous iterations of this paper only showed the most recent seven years, this time series has been extended back to 2000 due to a request from SC14.

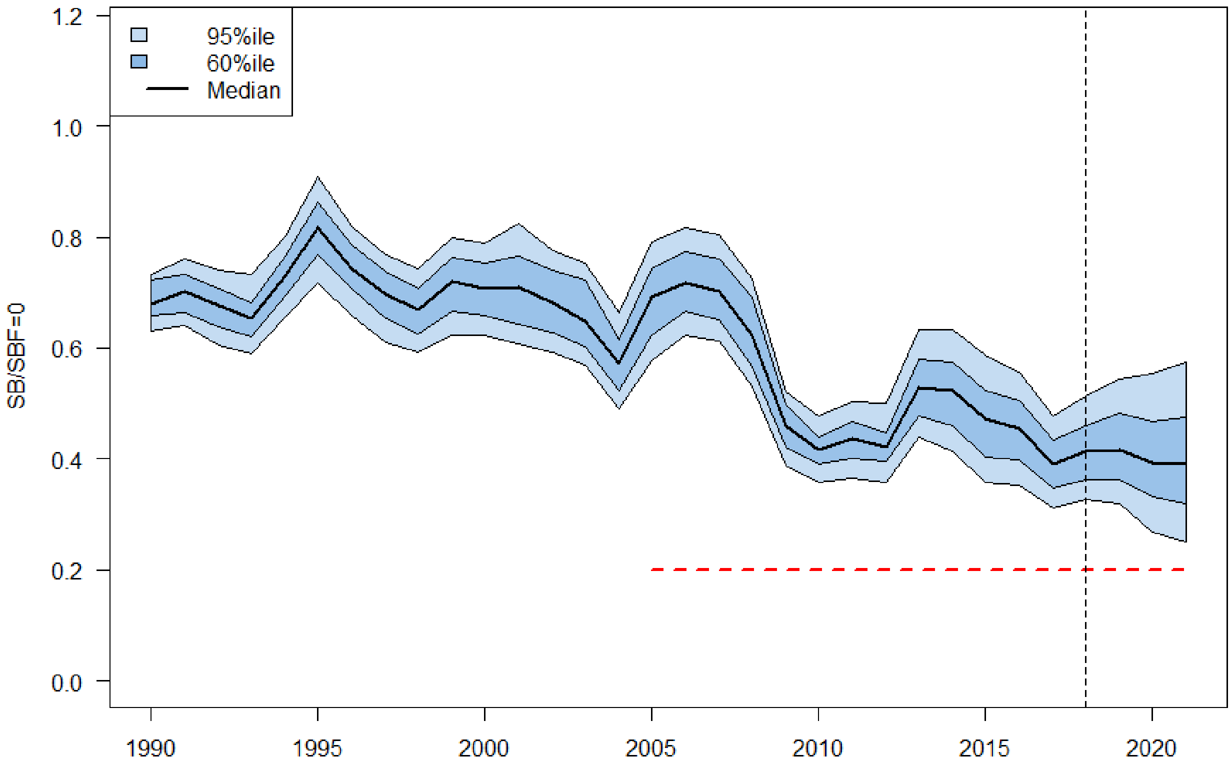
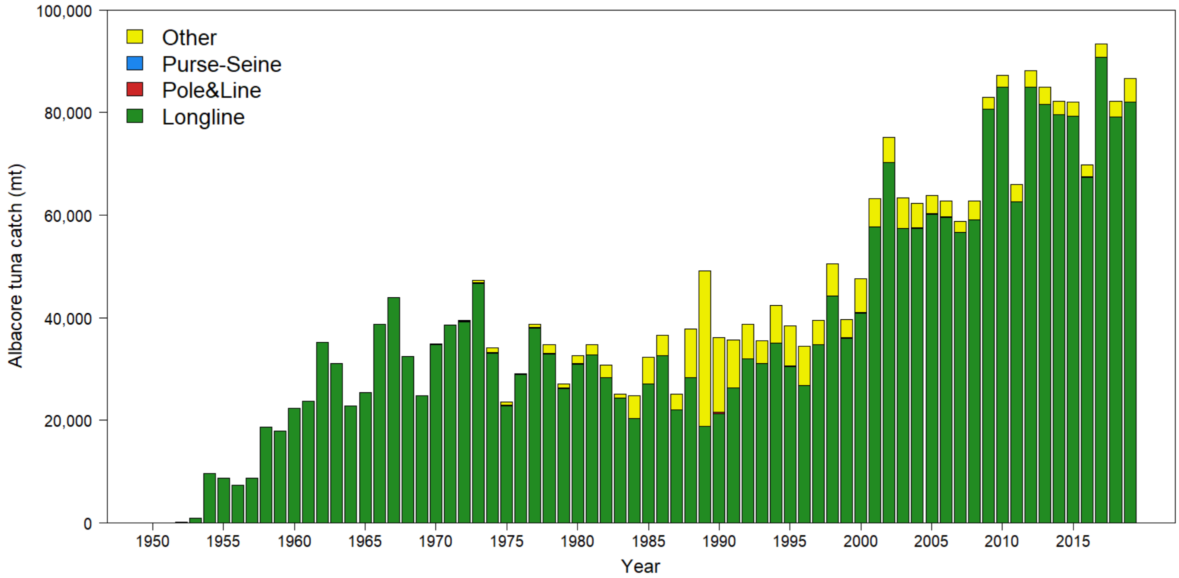


Figure 8: Skipjack spawning biomass (SB/SB$_{F=0}$) from the uncertainty grid of assessment model runs for the period 1990 to 2018 (the vertical line at 2018 represents the last year of the assessment), and stochastic projection results for the period 2019 to 2021 assuming actual catch and effort levels in 2019, and that 2019 fishing levels continued until 2021. During the projection period (2019-2021) levels of recruitment variability are assumed to match those over the time period used to estimate the stock-recruitment relationship (1982-2017). The red dashed line represents the agreed limit reference point.

South Pacific albacore



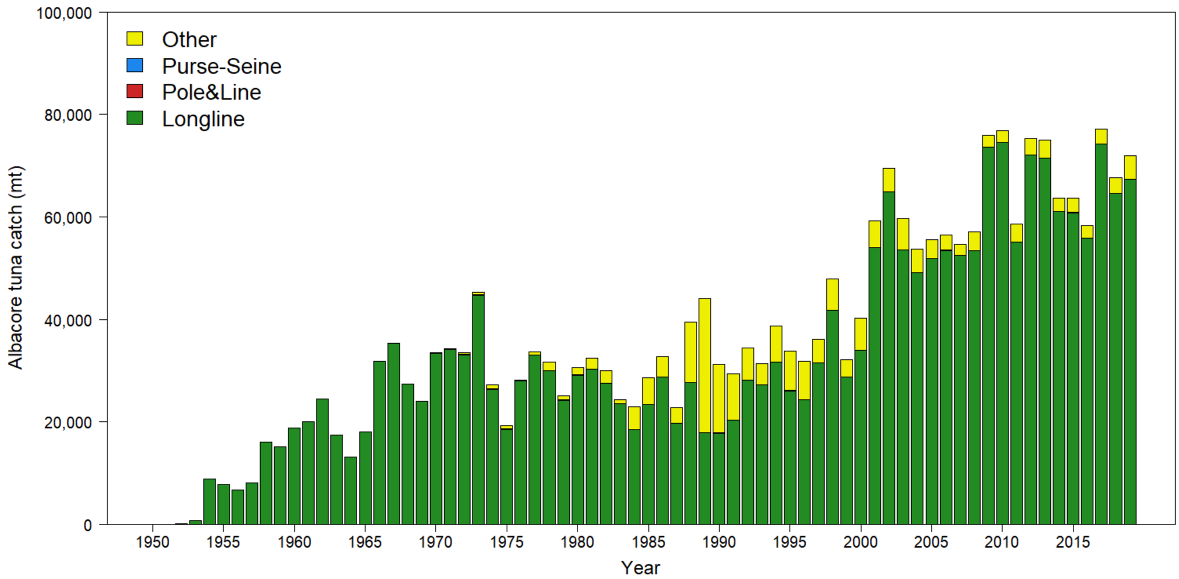


Figure 9: South Pacific albacore tuna catch by gear type and year for the South Pacific as a whole (top) and WCPFC-CA south of the equator (bottom). Note: 'Other' gear here is primarily troll gear, but includes driftnet catches in the 1980s and early 1990s.

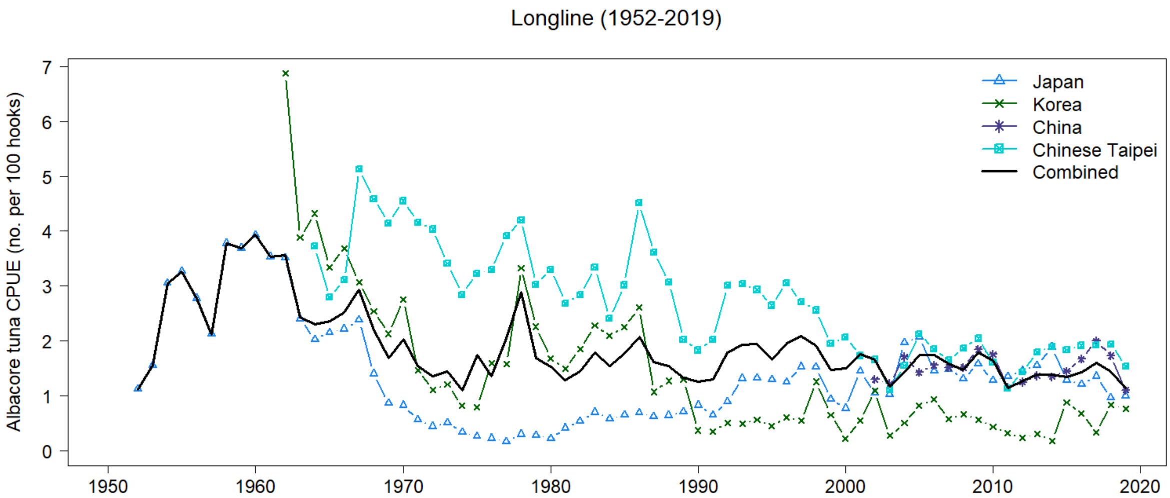


Figure 10: South Pacific albacore tuna catch per unit effort in the southern WCP-CA (south of 10°S) by year for major longline fleets.

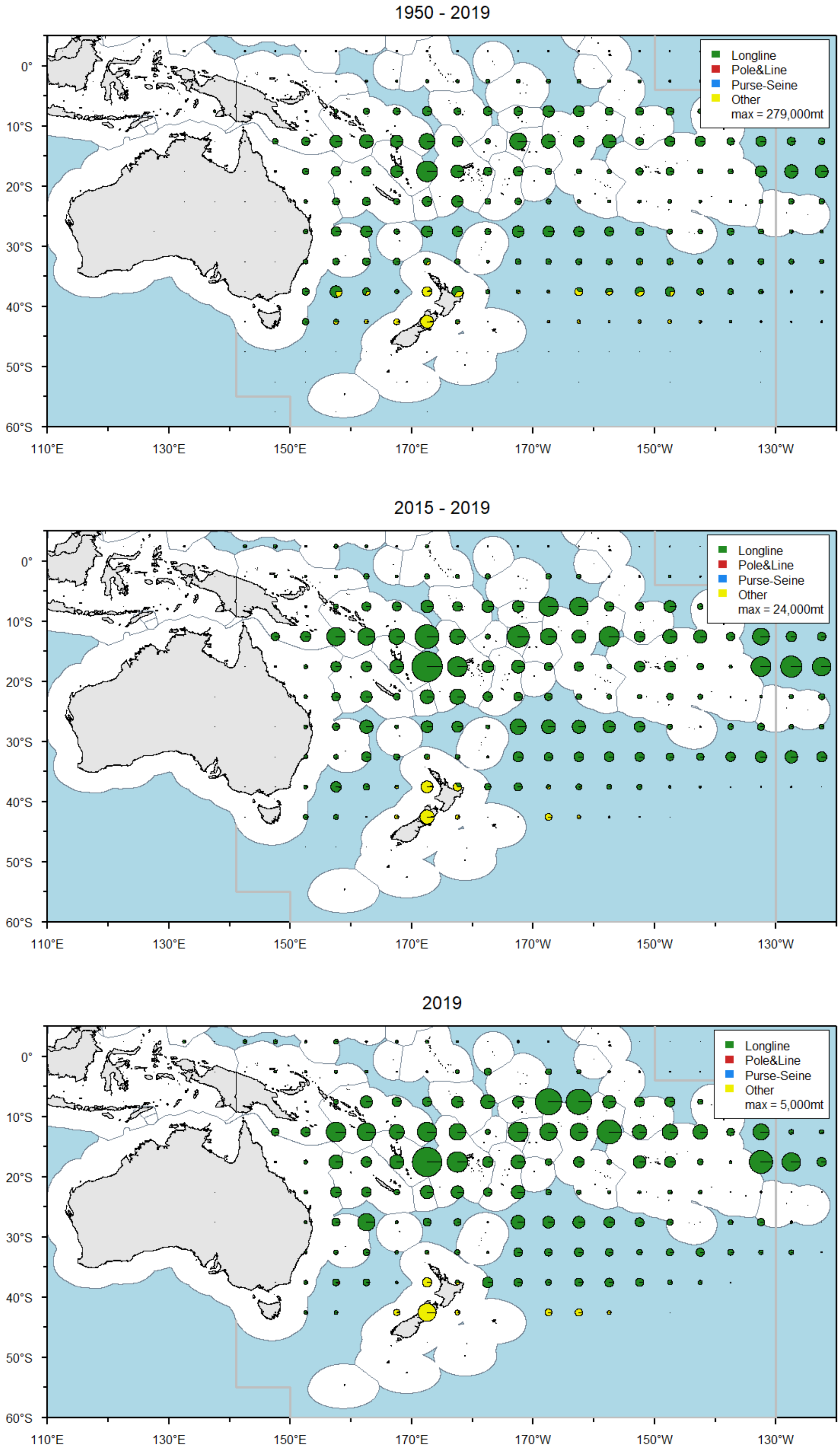


Figure 11: South Pacific albacore tuna catch distribution by gear type and 5°x 5° region for the entire Pacific Ocean for the period 1950-2019 (top), 2015-2019 (middle) and 2019 (bottom). Note that the scale differs between panels and the figure legends provide the catch associated with each maximum circle size.

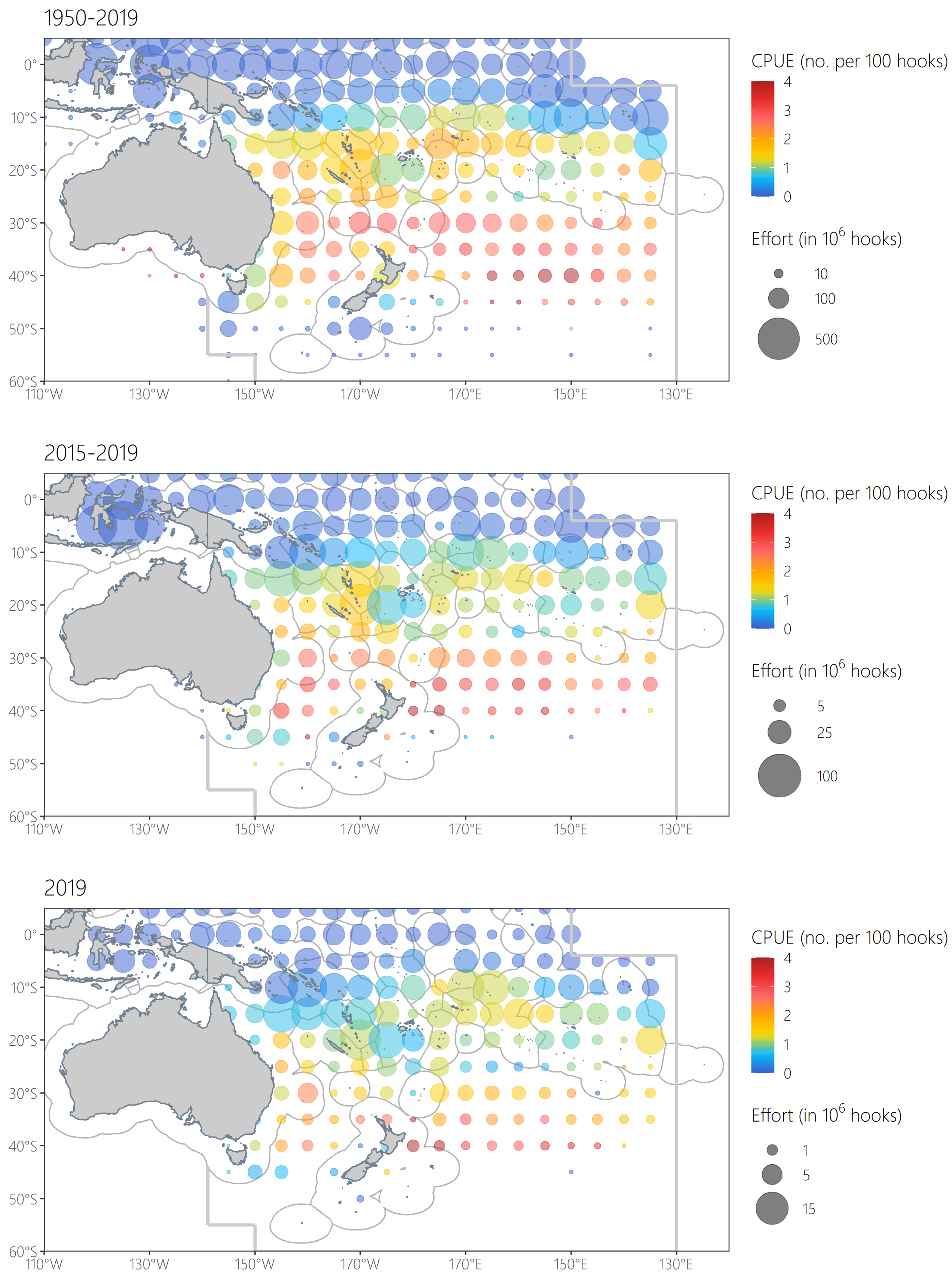


Figure 12: Distribution of 5^ox 5^o longline effort (represented by circle size) and South Pacific albacore tuna CPUE (represented by colour) for the period 1950-2019 (top), 2015-2019 (middle) and 2019 (bottom). Note the differences in scales between plots.

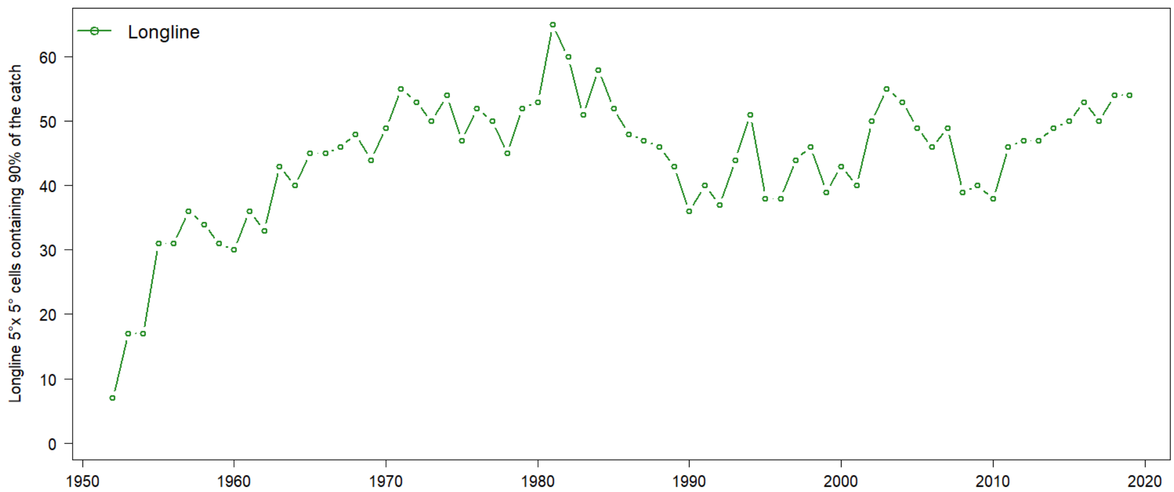


Figure 13: Spatial concentration of South Pacific albacore tuna catch for the longline fishery by year for the WCPO.

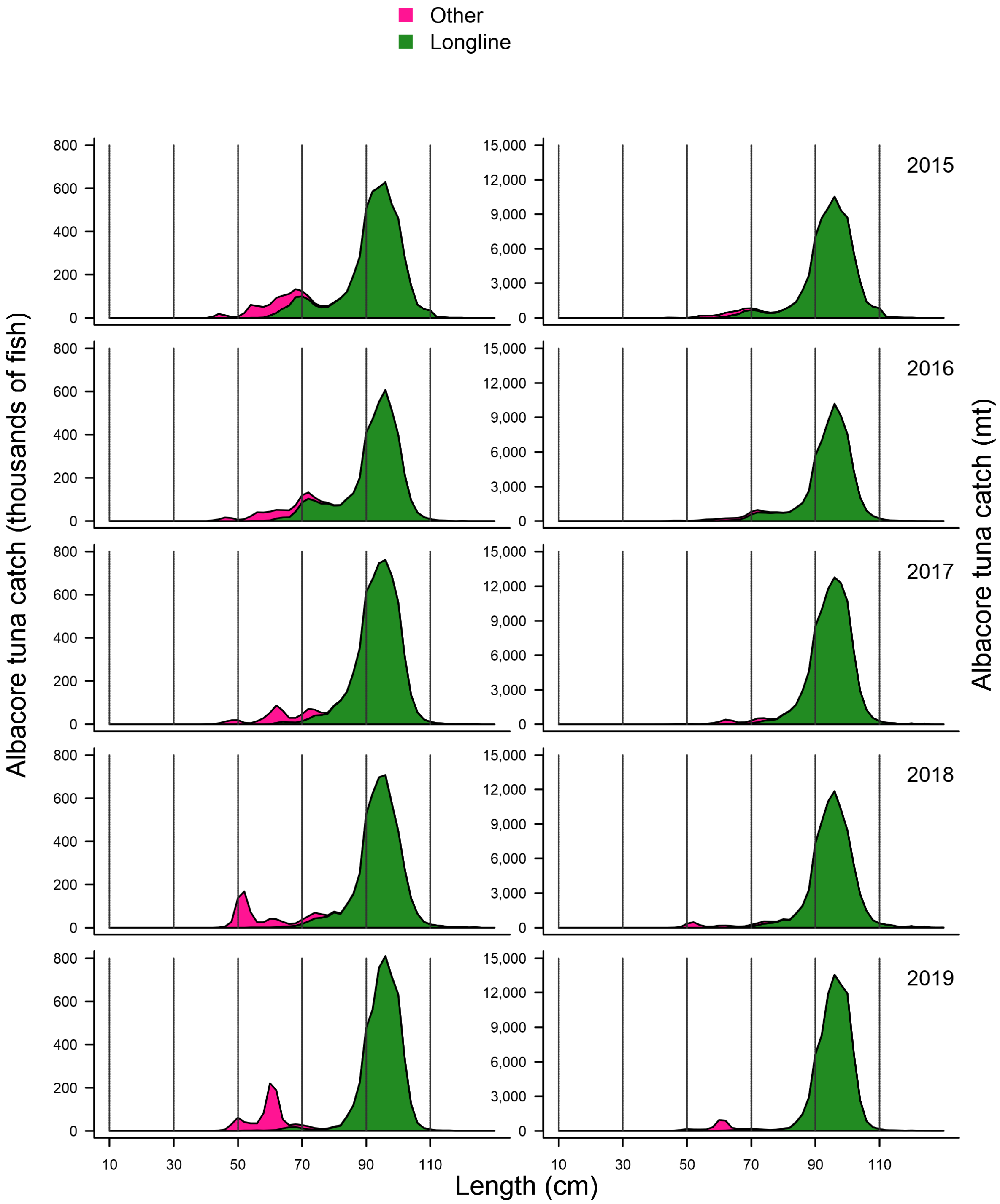


Figure 14: Catch-at-size of South Pacific albacore tuna by gear type and year for the WCPO. Catch is provided in thousands of fish (left) and metric tonnes (right). The grey vertical lines are guides to aid interpretation.

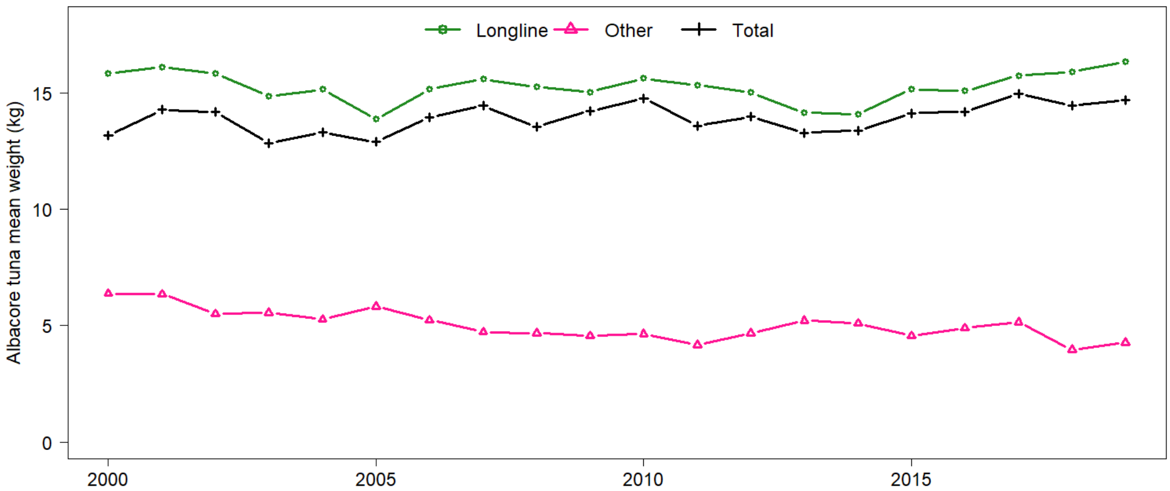


Figure 15: Mean weight of individual South Pacific albacore tuna taken by gear and year for the WCPO. The 'total' line represents the overall mean catch-at-size by number.

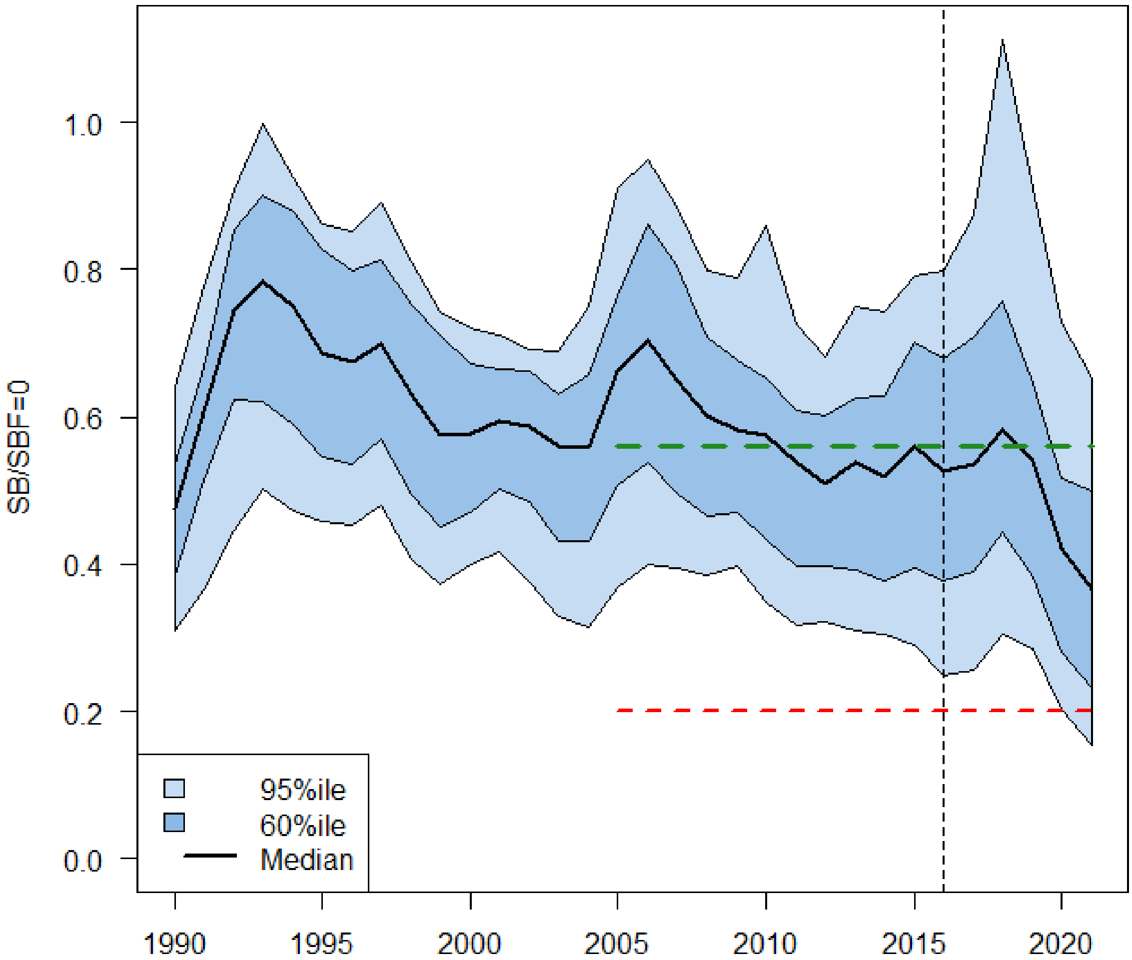


Figure 16: Stochastic projection results of albacore tuna spawning biomass ($SB/SB_{F=0}$) from 2016 using actual catch and effort levels in 2017, 2018, and 2019 and then through to 2021 assuming 2019 levels continued. Prior to 2016 the data represent the 60th and 95th percentiles of the uncertainty grid from the assessment models and the median. Levels of recruitment variability estimated for the period used to estimate the stock-recruitment relationship (1962-2016) assumed to continue in the future. Projections are from the model runs of Tremblay-Boyer et al., 2018, and are projected on the basis of albacore catch. The red dashed line represents the WCPFC agreed limit reference point (0.20), and the green dashed line the target reference point (0.56).

Bigeye

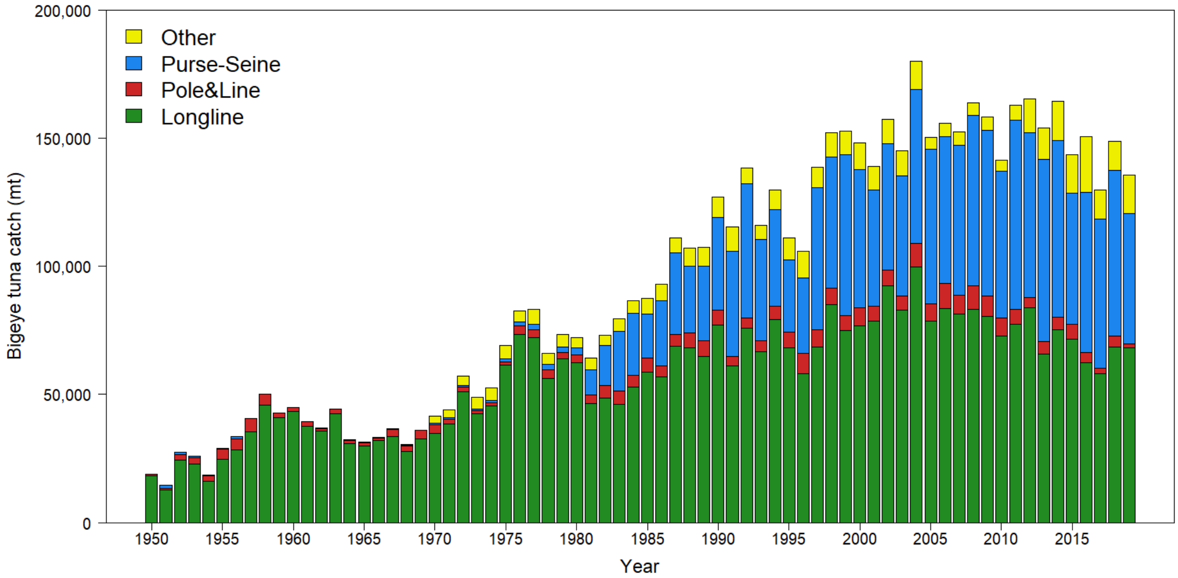


Figure 17: Bigeye tuna catch by gear type and year for the WCPFC-Convention Area.

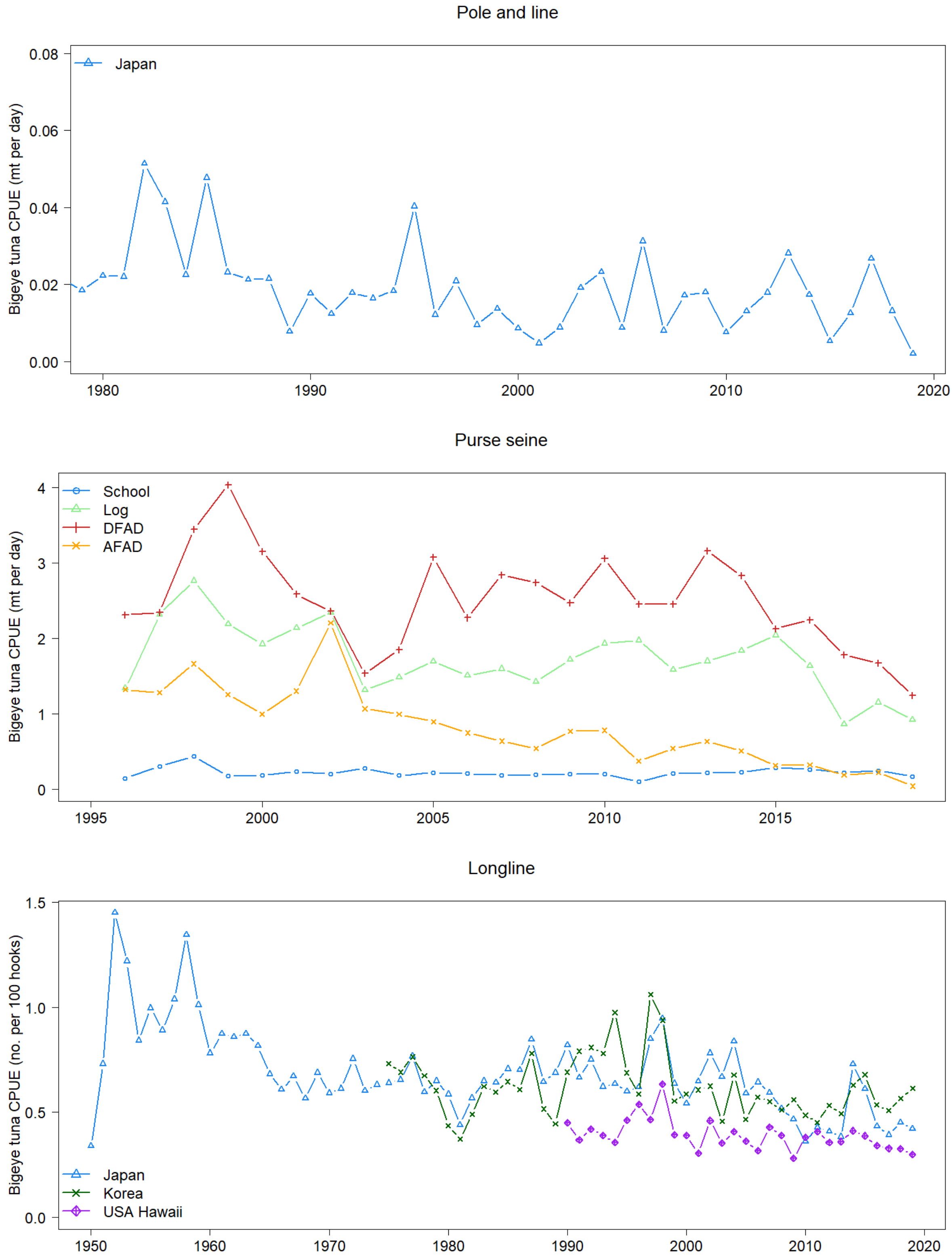


Figure 18: Bigeye tuna catch per unit effort in the tropical WCPO by year for major pole and line fishing fleets (top), purse seine for the major set types (middle), and tropical longline for three fleets (bottom; 20°N to 10°S, WCP-CA). Note different time series lengths.

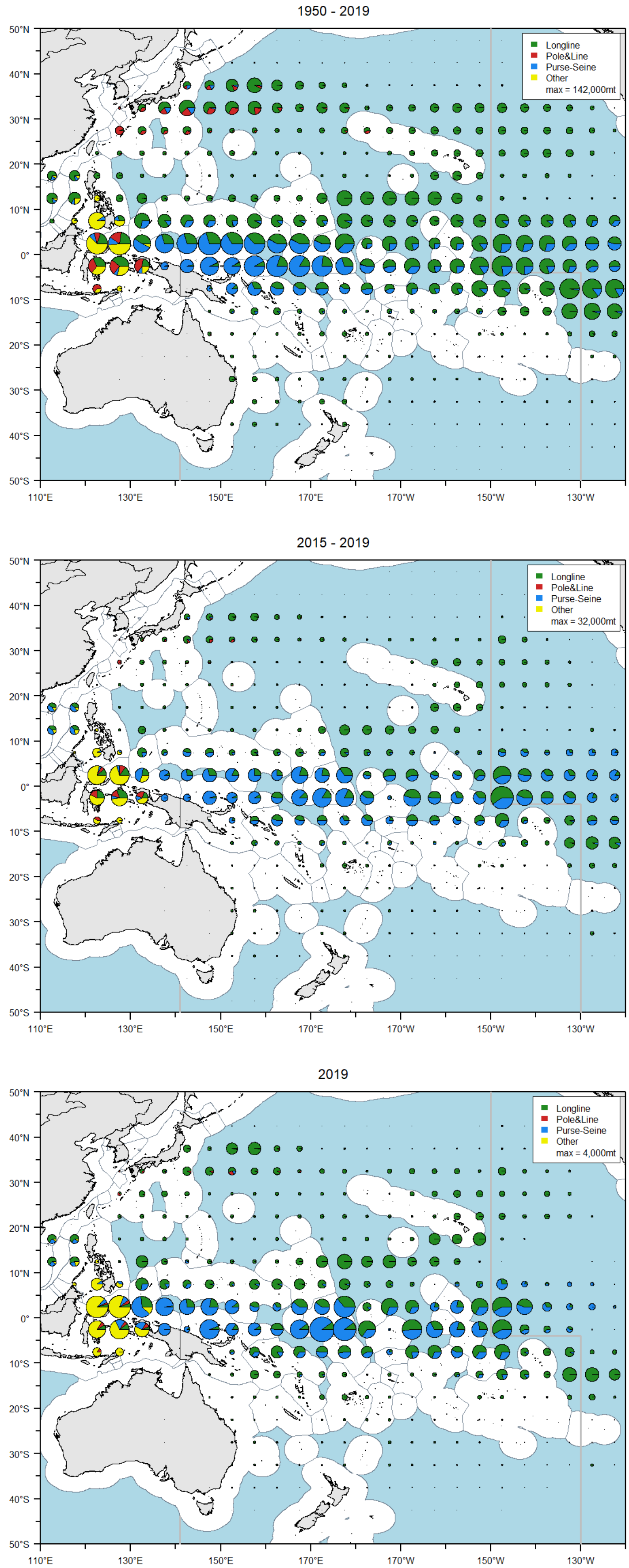


Figure 19: Bigeye tuna catch distribution by gear type and 5^{o}x 5^o region for the entire Pacific Ocean for the period 1950-2019 (top), 2015-2019 (middle) and 2019 (bottom). Note that the scale differs between panels and the figure legends provide the catch associated with each maximum circle size.

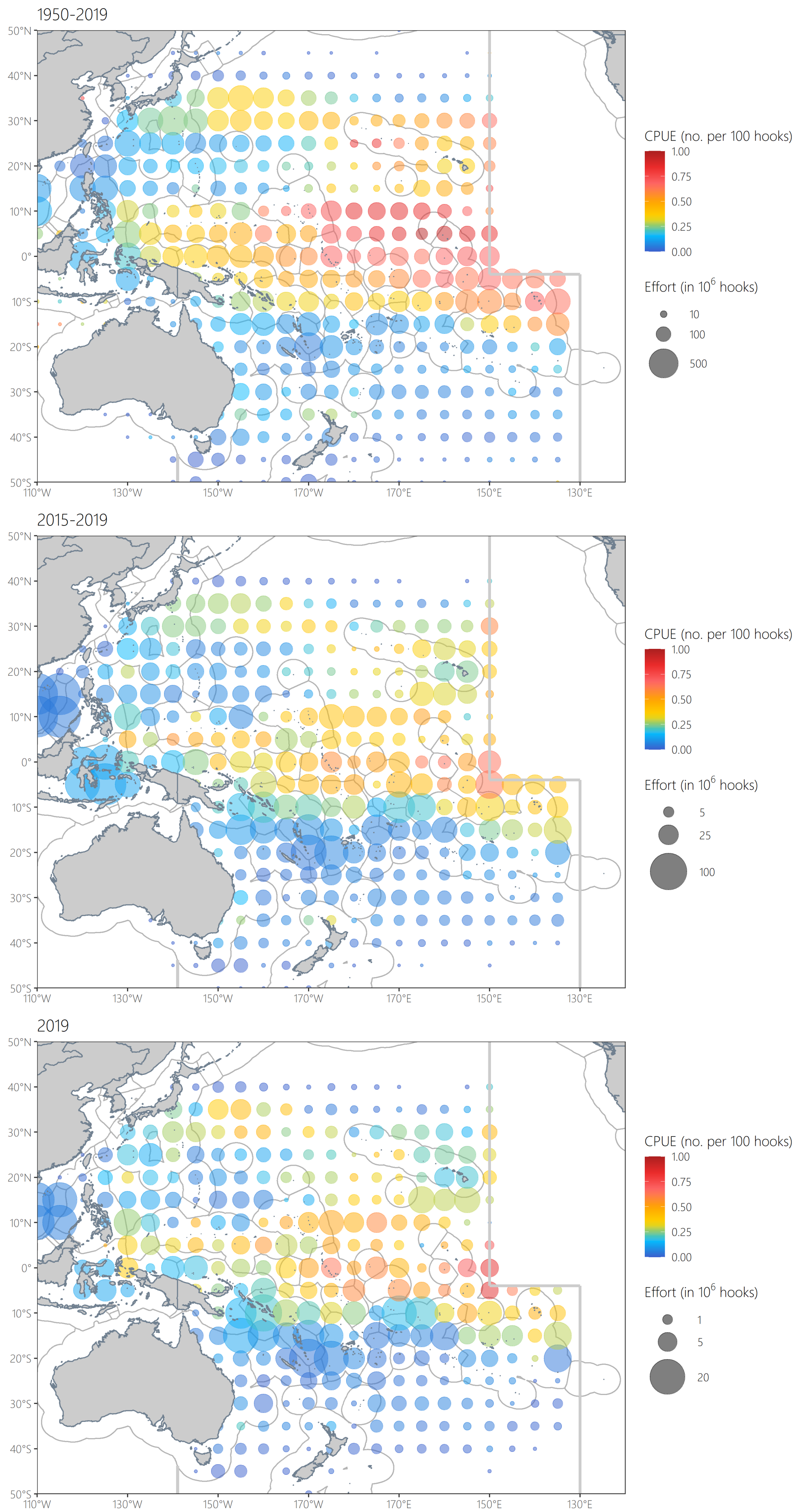


Figure 20: Distribution of 5°x 5° longline effort (represented by circle size) and bigeye tuna CPUE (represented by colour) for the period 1950-2019 (top), 2015-2019 (middle) and 2019 (bottom). Note the differences in scales between plots.

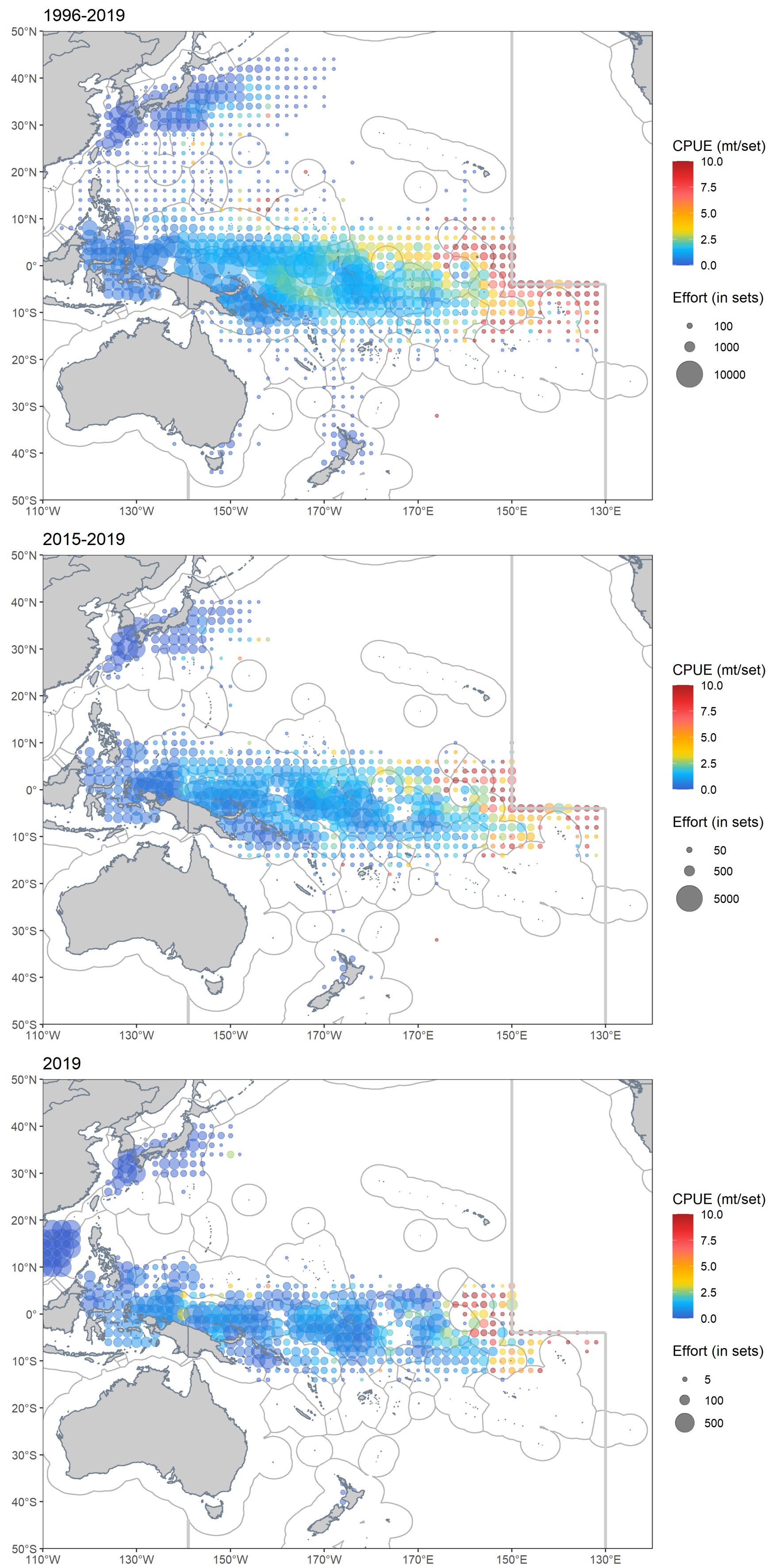


Figure 21: Distribution of 2°x 2° purse seine effort (represented by circle size) and bigeye tuna CPUE (represented by colour) for the period 1996-2019 (top), 2015-2019 (middle) and 2019 (bottom). Note the differences in circle size scale between plots.

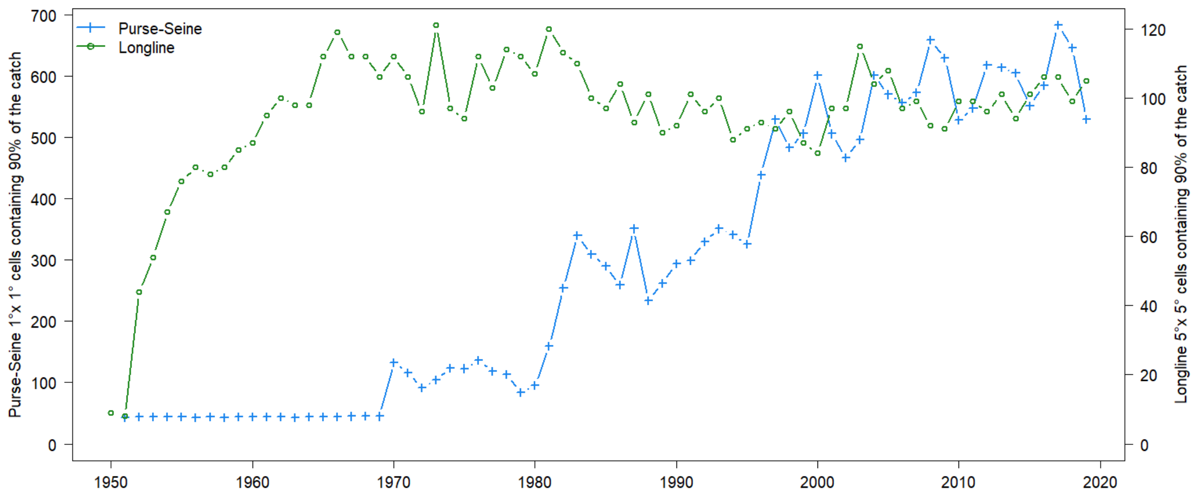


Figure 22: Spatial concentration of bigeye tuna catch for purse seine and longline by year for the WCPO.

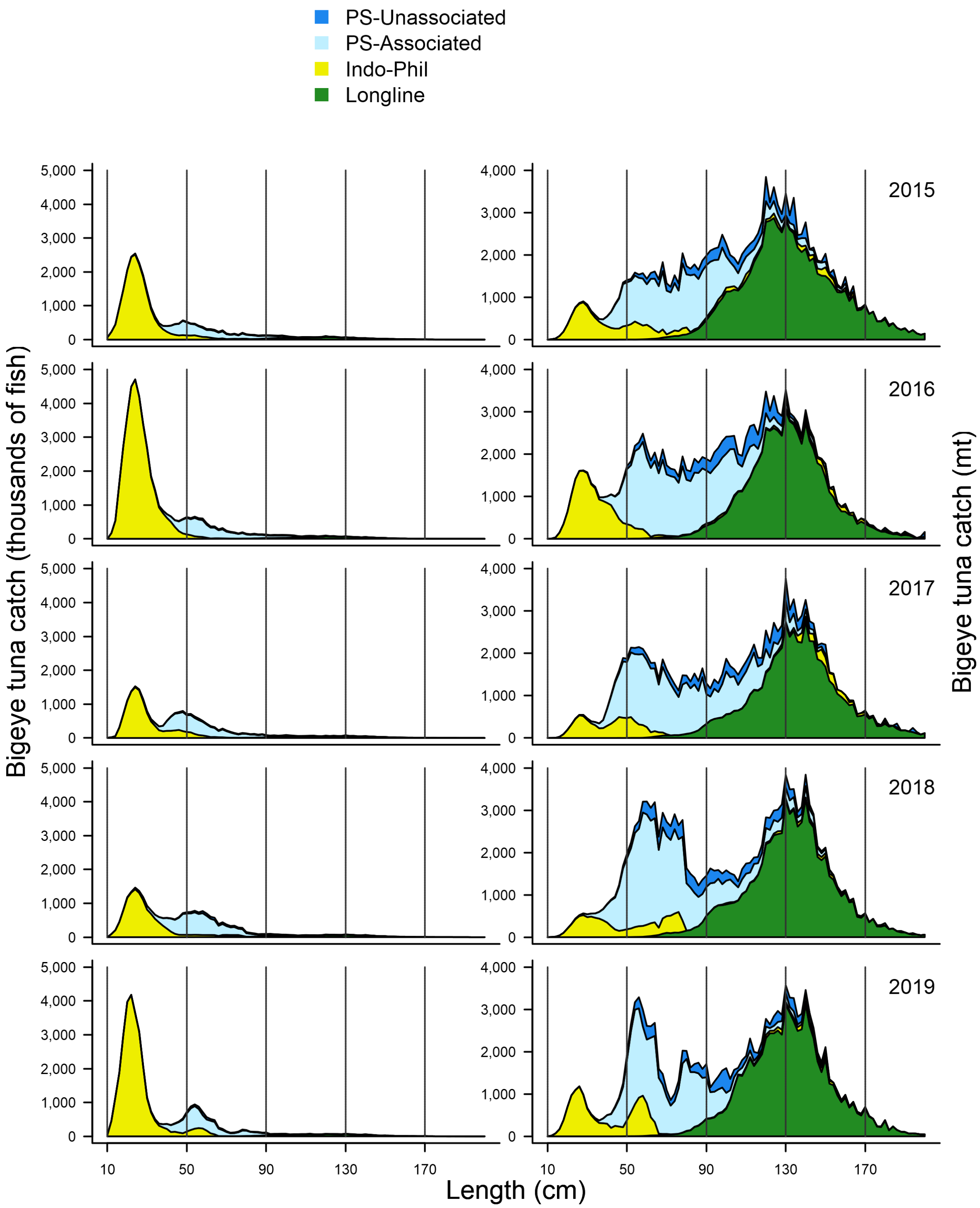


Figure 23: Catch-at-size of bigeye tuna by gear type and year for the WCPO. Catch is provided in thousands of fish (left) and metric tonnes (right). The grey vertical lines are guides to aid interpretation.

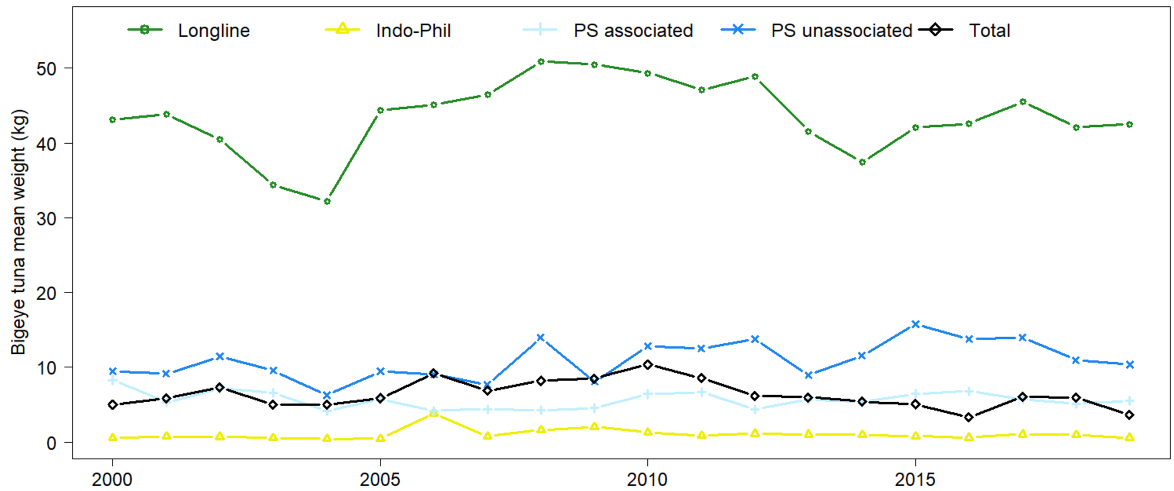


Figure 24: Mean weight of individual bigeye tuna taken by gear and year for the WCPO. The 'total' line represents the overall mean catch-at-size by number.

Yellowfin

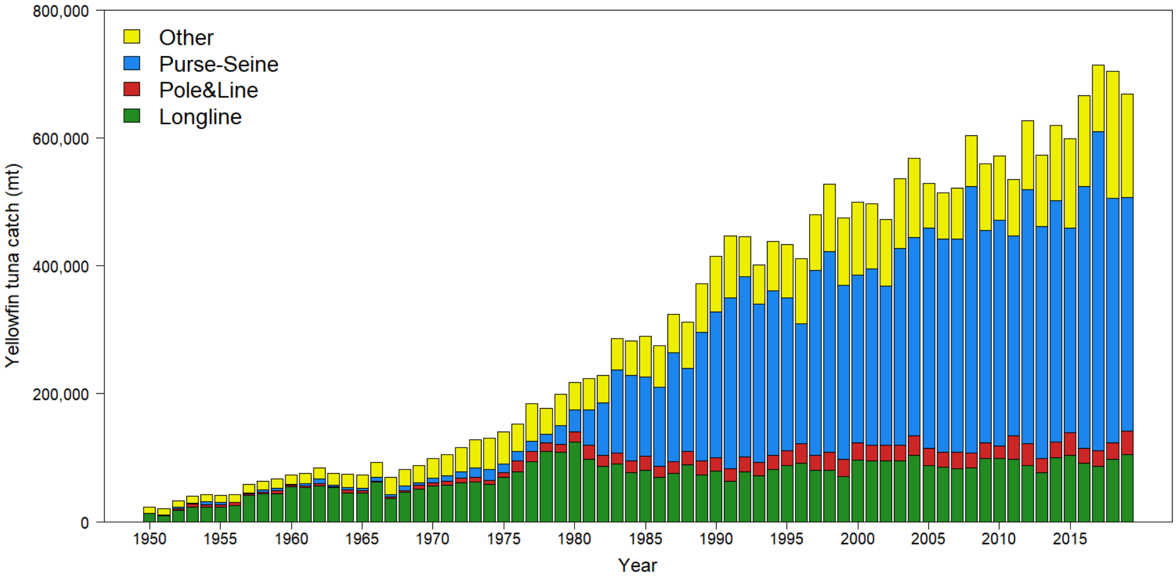


Figure 25: Yellowfin tuna catch by gear type and year for the WCPFC-Convention Area.

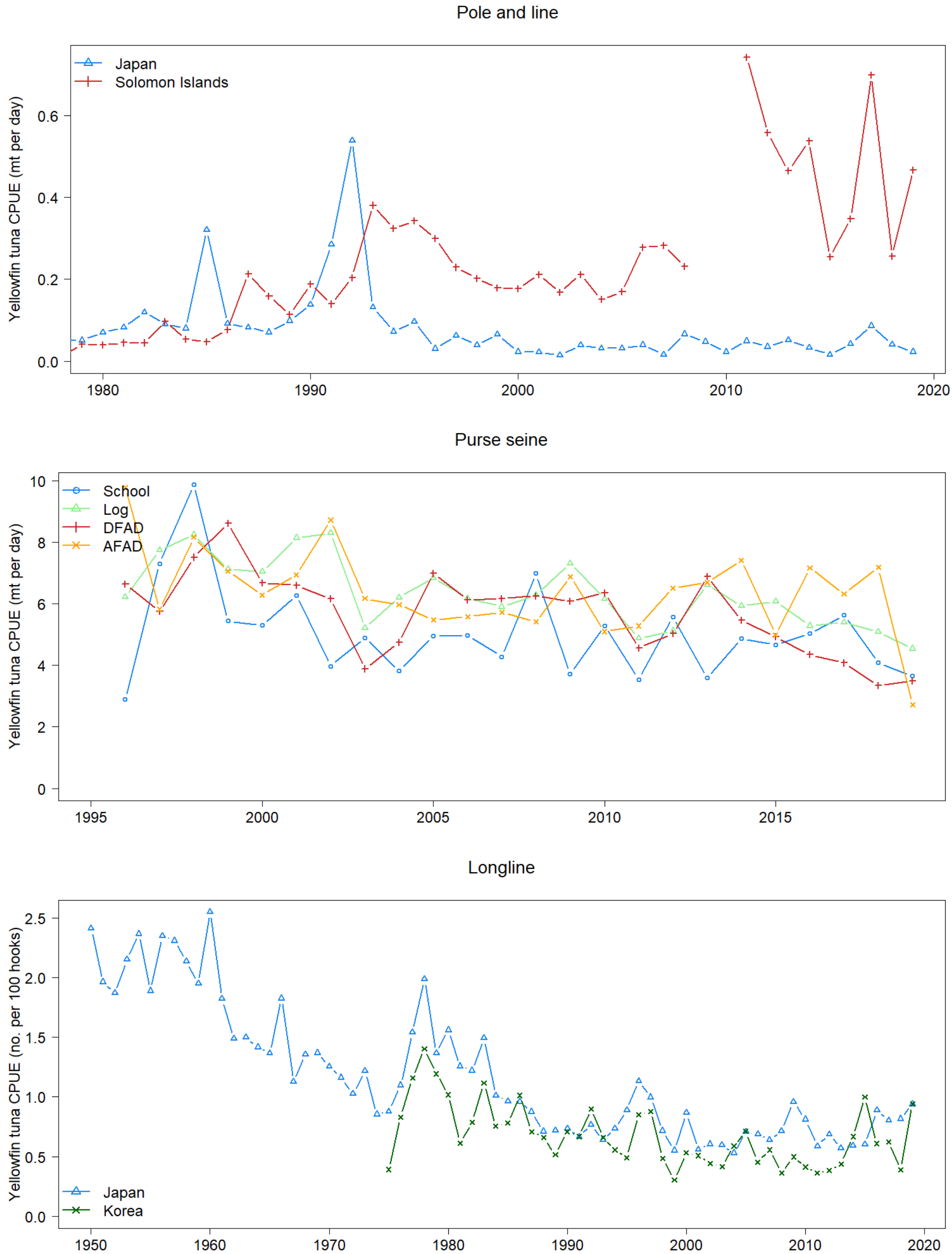


Figure 26: Yellowfin tuna catch per unit effort in the tropical WCPO by year for major pole and line fishing fleets (top), purse seine for the major set types (middle), and tropical longline for three fleets (bottom; 20°N to 10°S, WCP-CA). Note different time series lengths.

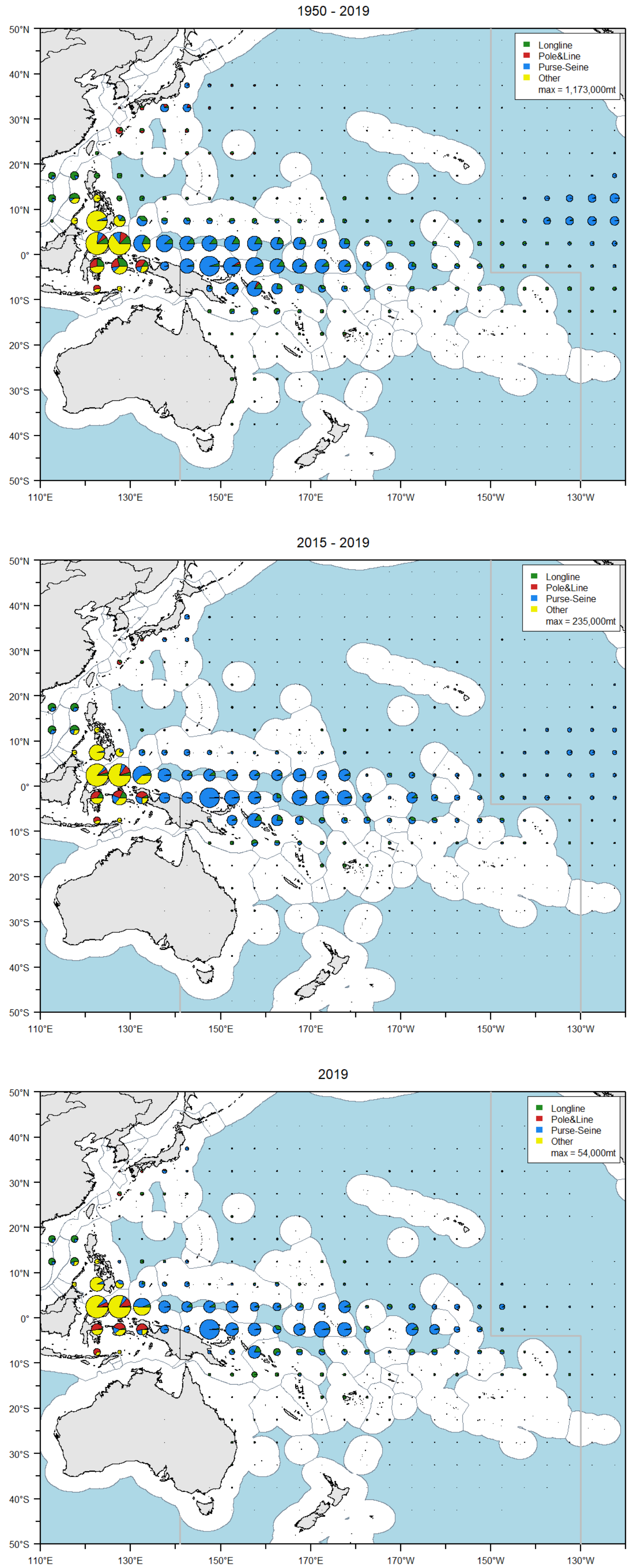


Figure 27: Yellowfin tuna catch distribution by gear type and 5^ox 5^o region for the entire Pacific Ocean for the period 1950-2019 (top), 2015-2019 (middle) and 2019 (bottom). Note that the scale differs between panels and the figure legends provide the catch associated with each maximum circle size.

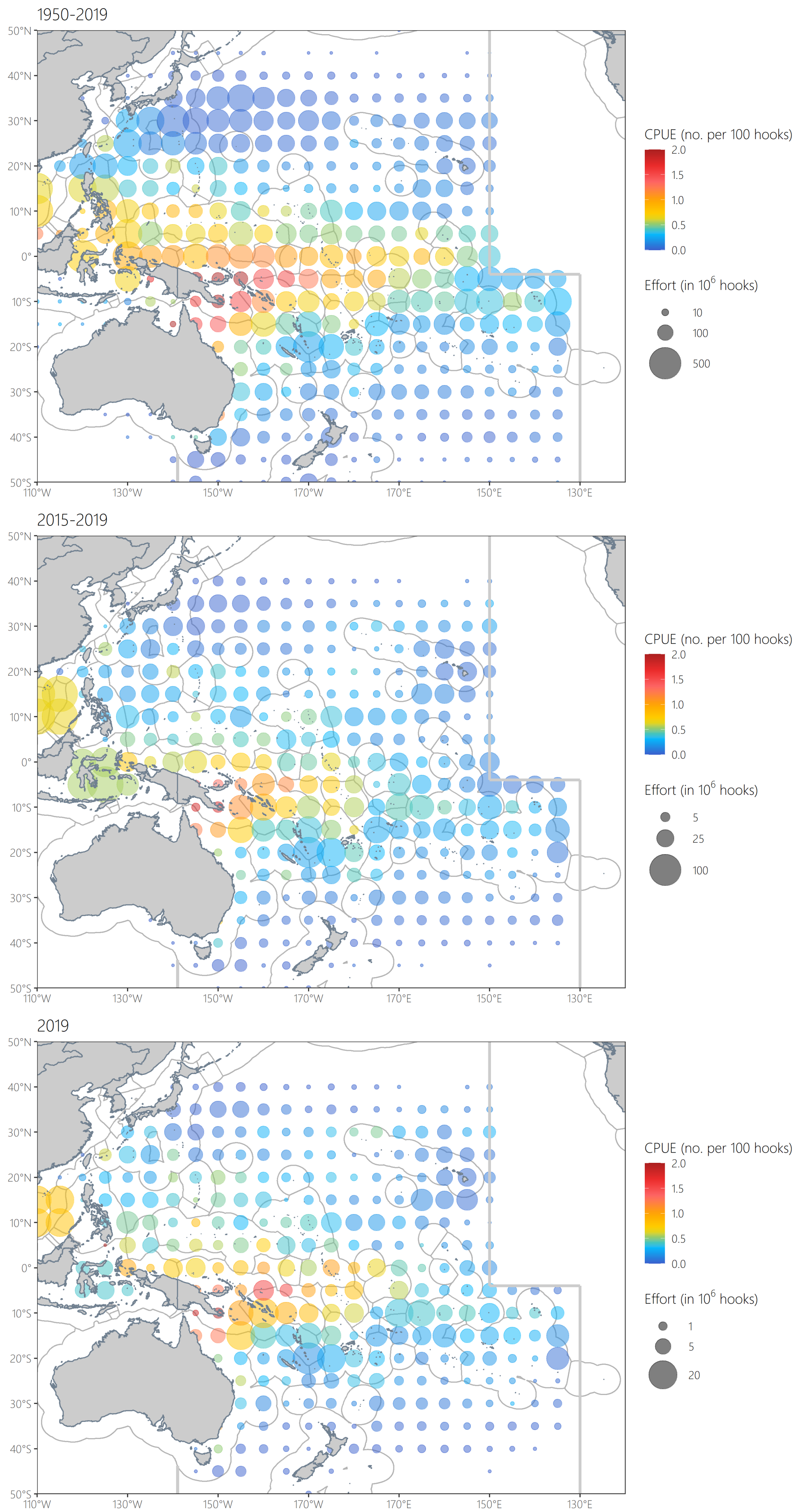


Figure 28: Distribution of 5°x5° longline effort (represented by circle size) and yellowfin tuna CPUE (represented by colour) for the period 1950-2019 (top), 2015-2019 (middle) and 2019 (bottom). Note the differences in scales between plots.

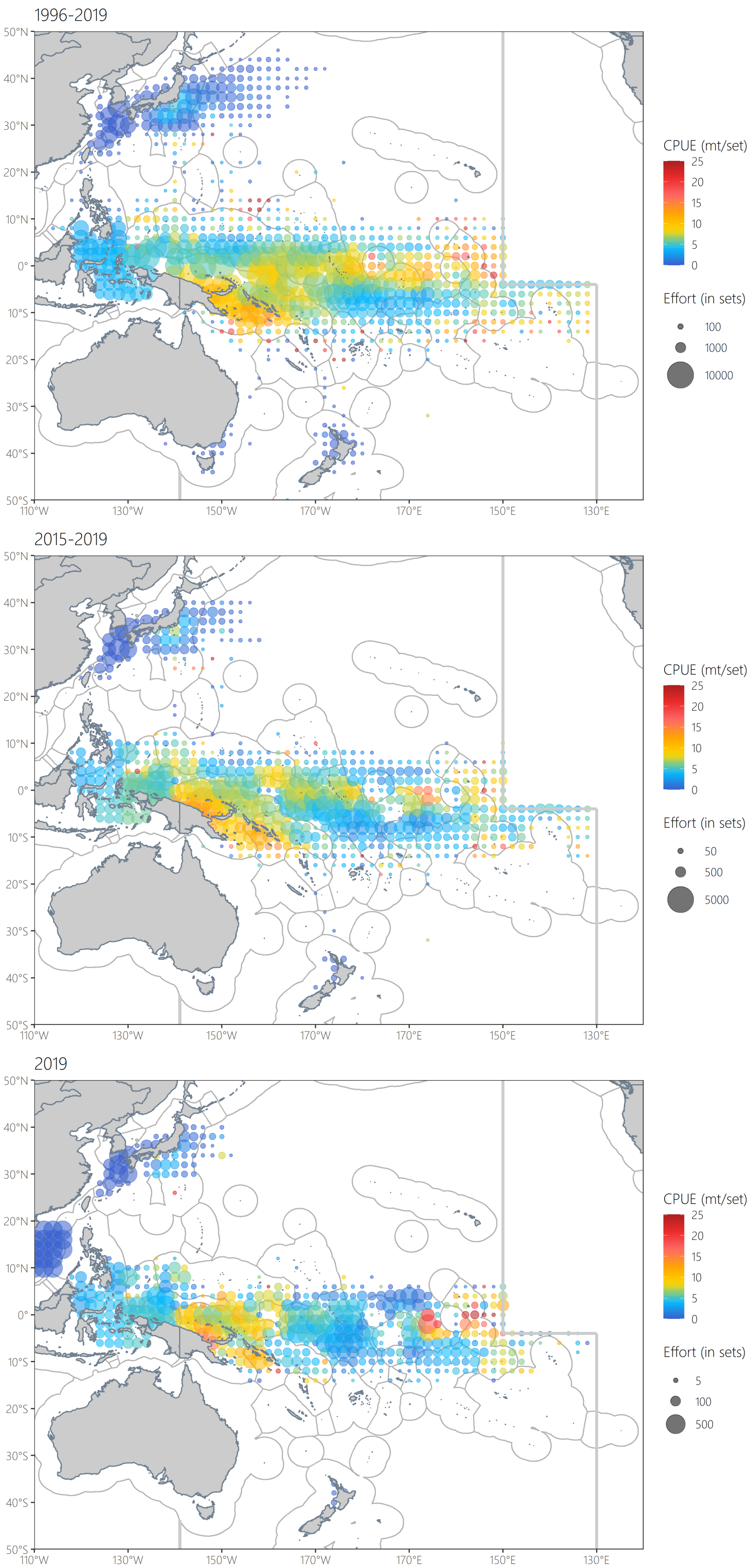


Figure 29: Distribution of 2^{o}x 2^o purse seine effort (represented by circle size) and yellowfin tuna CPUE (represented by colour) for the period 1996-2019 (top), 2015-2019 (middle) and 2019 (bottom). Note the differences in circle size scale between plots.

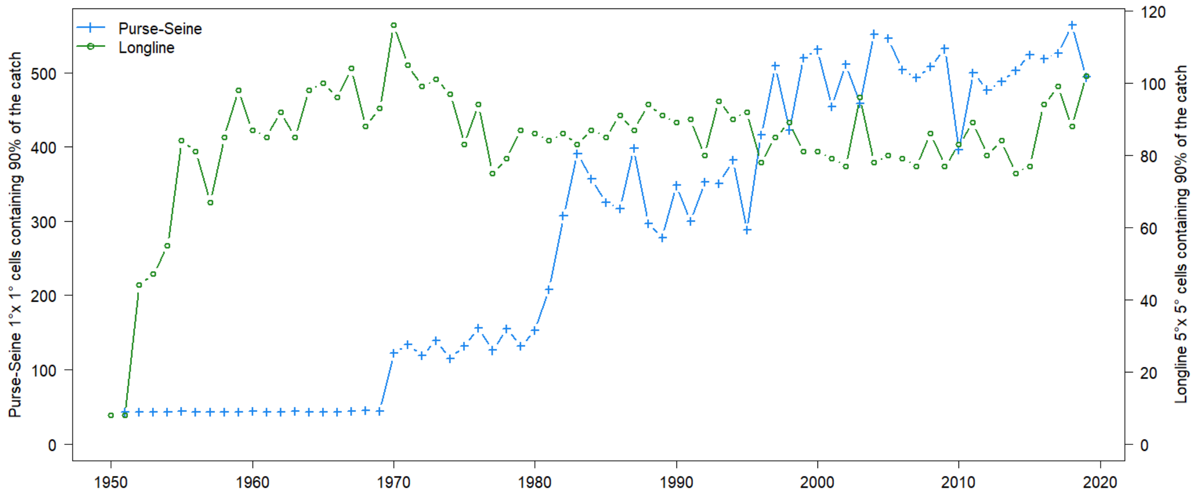


Figure 30: Spatial concentration of yellowfin tuna catch for purse seine and longline by year for the WCPO.

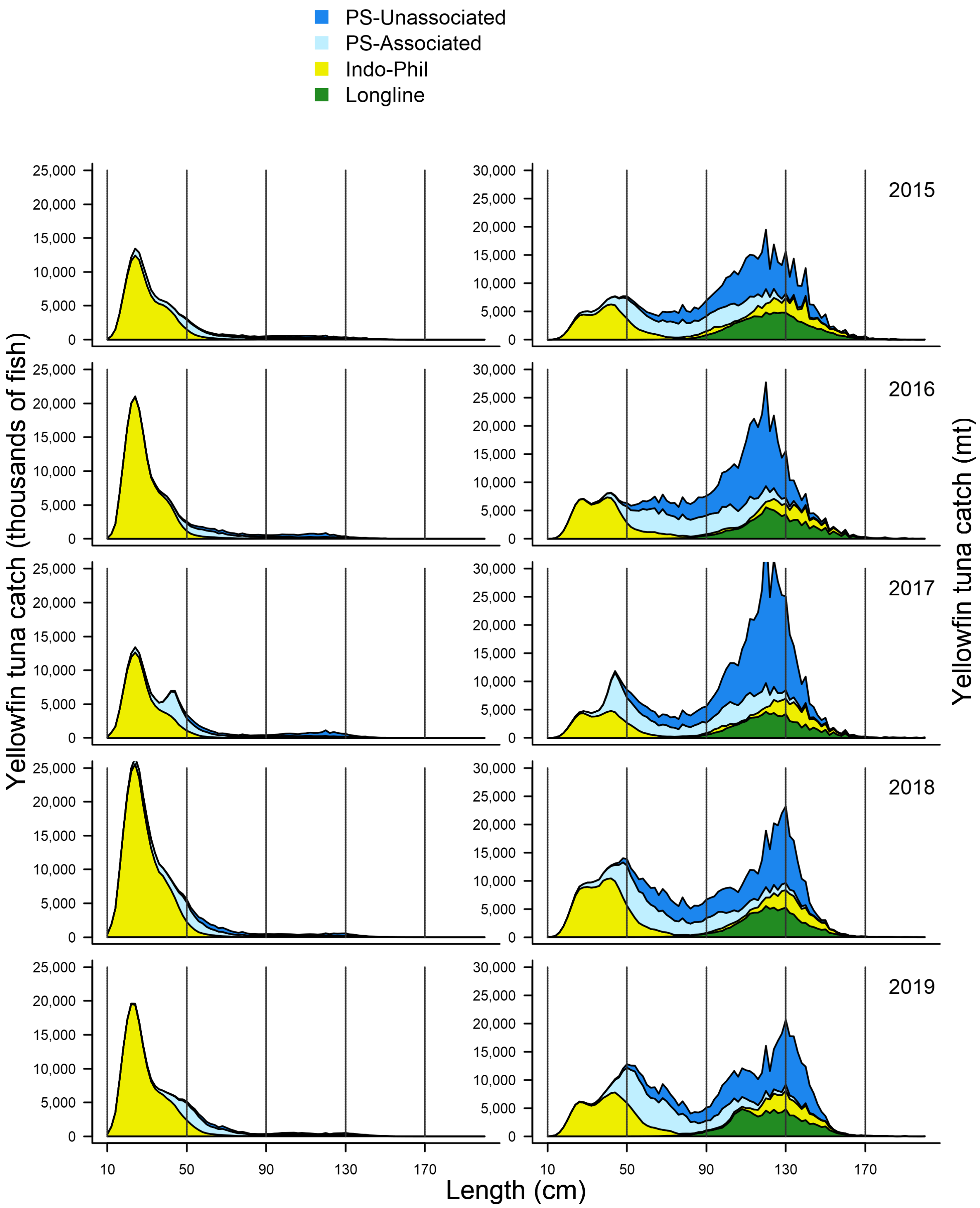


Figure 31: Catch-at-size of yellowfin tuna by gear type and year for the WCPO. Catch is provided in thousands of fish (left) and metric tonnes (right). The grey vertical lines are guides to aid interpretation.

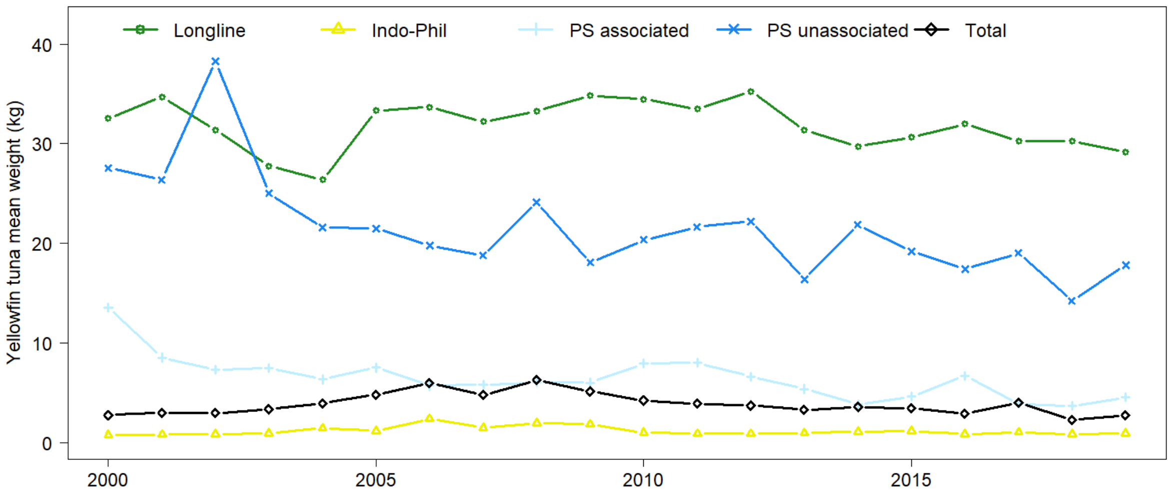


Figure 32: Mean weight of individual yellowfin tuna taken by gear and year for the WCPO. The 'total' line represents the overall mean catch-at-size by number.